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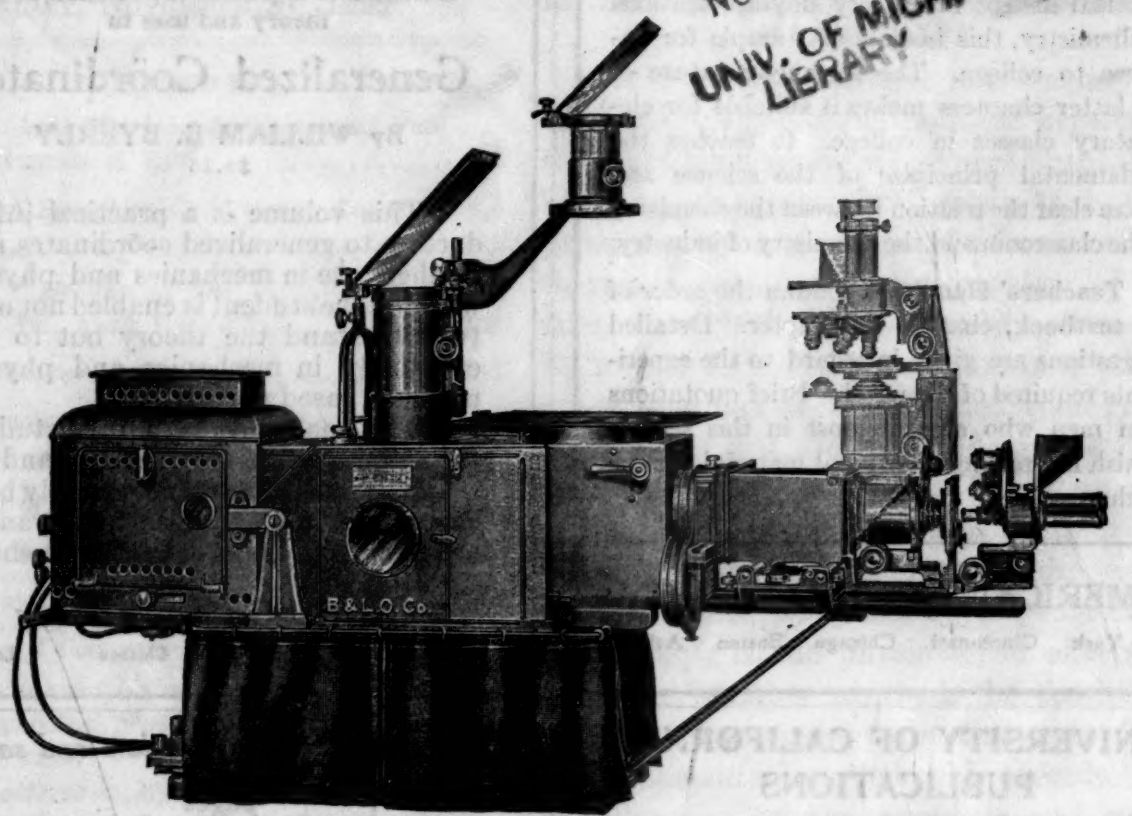

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IS THE EIGHT-HOUR WORKING-DAY RATIONAL?[1]

MAY I say at once that it is not my intention to consider the political aspects of the eight-hour problem? There should not be political aspects in a topic that is so preeminently a problem of science. Furthermore, considered as a problem of science, the eight-hour day is rarely viewed in its proper light. In the voluminous literature that has been published concerning it economic and social considerations have been too often paramount. Yet in an adequate analysis of it the real basis of the whole matter is physiological—the eight-hour problem is primarily a problem of physiology; if the physiological effects of any kind of labor are bad, the conditions of such labor ought to be changed. This is fundamental, and should precede any consideration of the economic and social effects of a change of conditions. This basic fact is continually overlooked.

The eight-hour day is the result of an evolution, beginning in human aspiration and fostered largely by humanitarian motives. That baser considerations, the desire to earn wages at the minimum cost of personal effort, impel many advocates of the eight-hour principle, can not be denied, but this need not blind us to the fact that there are higher grounds on which the problem can legitimately be discussed.

In the evolution of the eight-hour day England, of all countries, presents the most interesting history. Diligent search has failed to reveal the origin of the tra-

[1] Read before the Section on Industrial Hygiene of the American Public Health Association, Cincinnati, October 25, 1916.

ditional division of the diurnal twenty-four hours into eight hours each of work, recreation and sleep. It is said that the customary duration of the working-day of the fifteenth century was eight hours. Whether this be true or not, during the subsequent three hundred years all the evils of unrestricted labor flourished vigorously. At the beginning of the nineteenth century most English artisans were accustomed to work from eleven to fifteen hours in the day. No delicate physiological tests were needed to demonstrate what such a system was doing to destroy the vital mechanisms of men, women and children. The results were sufficiently obvious, and the next one hundred years were marked by a series of struggles between workers and humanitarians on the one side, and capitalists on the other, in which progress toward a physiological working-day was gradually, though slowly, made. After sporadic reductions of the working-period to twelve hours or less, a ten-hour movement was succeeded in time by a nine-hour movement, and by the middle of the century the eight-hour day had been definitely proposed. It was won first, not in the mother-country, but by the artisans of Melbourne, Australia, in 1856, and this date marks the beginning of achievement of the eight-hour movement. In the United States agitation in its favor began immediately after the close of the Civil War, stimulated, no doubt, by the great extension of industrial work which then occurred. Thus, since the middle of the nineteenth century the eight-hour day has been the goal of labor. Such a day presupposes one day's rest in every seven and thus signifies a forty-eight-hour week. It is usually coupled, however, with an extra half holiday, which for the majority of persons would be taken on Saturday afternoon. In this manner the week's work would be reduced to forty-four hours, and this represents the present demand of the eight-hour movement. Partly by law and partly by private agreement between employer and employed the eight-hour day has been granted in recent years to one group of workers here and another there, usually localized groups and rarely including all the workers in a single industry of a single country. At the present time it has become legalized in our own country for public employees and employees on public works in the federal service and in thirty states and territories; for miners in the service of fourteen states; for employees in smelting and reduction works in nine states; for railroad telegraphers in six states; for employees in rolling, rod and stamp mills in five states; for employees in tunnels and in coke ovens in three states; for employees in blast furnaces, in cement and plaster mills, and those who work under high air pressure in two states; for employees in electric light and power plants, glass works and irrigation works in one state; and for employees in day's work, unless otherwise stipulated, in nine states. In 1913 of the 1,276,048 employees constituting the shop force of the 51,118 factories in the state of New York, 354,641, or 28 per cent., worked 51 hours or less in the week. The eight-hour day will doubtless ultimately be achieved by a very large proportion of the world's workers in the more highly civilized countries.

What should determine the duration of daily labor? Here I would place, as of first importance, the physiological effects of the work and, as secondary and subordinate factors, its economic and social features.

The physiological effects of labor are now so well known as to require here only brief mention. The expenditure of energy by the bodily organs involves chemical and physical changes in them which, if con-

tinued, leads to the physiological state of fatigue. Fatigue is characterized chemically by the diminution within the acting tissues of chemical substances that have previously been stored within the living cells and either serve as sources of energy or are otherwise essential to tissue activity; and by the appearance within the living cells of other chemical substances, products of katabolic action, which are known as fatigue substances and react upon the tissues to decrease their power of responding to stimuli. If the same amount of work as before is then to be performed by the organs, the nervous system must send to them more powerful impulses, and when this becomes no longer possible the amount of work decreases. Fatigue substances spread from the place of their origin to other organs and react upon them, and thus the activity of one physiological mechanism, such, for example, as a neuromuscular mechanism, fatigues others. In fatigue the senses are less acute; attention is less sharply focused; the power of discrimination is lessened; the muscles are weakened; the quickness and the accuracy of muscular action are decreased; glandular secretions seem to be decreased; the heart-beat may be slowed or, in extreme cases, possibly quickened and irregular; the blood vessels of the skin are dilated and draft an undue quantity of blood away from the brain. In fatigue the sense of weariness obtrudes and oppresses; but it can not be too strongly emphasized or too often reiterated that the feeling of fatigue is a very uncertain index of the presence of a measurable degree of the fatigue of the tissues. The feeling may, indeed, appear just at the time when its warning note is really needed; but it may sound an unduly early and a false alarm; and again, and especially when other potent psychic influences inhibit it, its coming may be unduly postponed. It is a fitful, capricious thing, and this fact is too often overlooked in the consideration of industrial fatigue.

All these physiological changes may be within normal limits, and by rest the irritability of the tissues can then be readily restored and the freshness of sensation and the vigor of mind and muscle can be brought back. But if the work has been too strenuous or too long-continued, if the chemical changes in the tissues have gone too far, or if rest has been unduly curtailed, fatigue passes over into a pathological state which is known as exhaustion and is far less easily recovered from. Not only is the power of achievement then further diminished, but susceptibility to specific disease is increased. There may be a general neurasthenia or other diseases of the nervous system, including nervous affections of the bodily organs. The will may be weakened, and resistance to immoral temptations may be lessened. Intemperance is one of the common results of bodily exhaustion, and even crime itself finds here one of its prolific sources. Resistance to infectious disease may be diminished, apparently because of a diminution of the protective antibodies. Thus, excessive fatigue may bring in its train many disastrous sequelæ with much physical and moral misery. The seeds of this more serious state are often sowed in industrial work, when the conditions of labor and living are such that a residuum of the fatigue of one day is carried over to the next and from day to day there is a cumulative, even if slight, diminution of physiological powers.

Let us develop a little further this topic of the physiological effects of labor. Laboratory experiments have demonstrated that the degree of fatigue of a muscle in a given time varies in accordance with both the amount of the weight lifted and the rapidity with which stimuli are sent to the tissue. Increasing the weight, or making

the muscle contract more rapidly, increases the degree of fatigue in a given time and, if continued, brings on earlier exhaustion. These facts have their counterpart in industrial work, for fatigue here too depends on the intensity and the rapidity of repetition of the individual acts performed by the laborer. In general it may be said that the introduction of so-called labor-saving machinery has diminished the intensity and increased the rapidity of repetition of the laborer's acts. Lifeless machines now often lift the heavy weights once raised by human muscles. Other lifeless machines, intricate and automatic, relieve the laborer of much of his former light muscular work. But these same machines need to be tended by human agencies and set the pace for human activities, and the tendency is ever toward increasing the quickness and the constancy with which sense-organs, brain, spinal cord, and muscles must act.

The introduction of periods of rest while a laboratory experiment with a muscle is in progress diminishes the fatigue of the moment, aids recuperation, and delays the oncoming of exhaustion. This is demonstrated very perfectly in each of us several times in a minute, since each beat of the heart is followed immediately by a resting period of sufficient length to enable the cardiac muscle completely to recuperate from the fatiguing effects of the previous contraction. The beneficial effects of similar resting periods in industrial labor are shown by the custom, not uncommon since the striking demonstration of the late Mr. Frederick Taylor in the lifting of heavy iron pigs, of giving workers occasional brief intervals of freedom from their tasks. The defenders of the twelve-hour duration of work in blast furnaces attempt to justify their attitude by the contention that the workman actually works but a fraction of the whole time on duty. A timely and striking instance of the value of frequent resting periods is reported by the British Health of Munition Workers Committee:

> Two officers at the front recently, for a friendly wager, competed in making equal lengths of a certain trench, each with an equal squad of men. One let his men work as they pleased, but as hard as possible. The other divided his men into three sets, to work in rotation, each set digging their hardest for five minutes and then resting for ten, till their spell of labor came again. The latter team won easily.

Fatigue is modified by the external conditions under which the work is performed. Thus, it was found by Scott and myself that when an animal had been exposed for six hours to an atmosphere with a temperature of 91° F. (33° C.) and 90 per cent. relative humidity the fatigue of the animal's muscles came on more rapidly and their working power was diminished by about one quarter. Certain industrial occupations too require their work to be performed in the midst of excessive heat and humidity and thus afford the conditions of an early oncoming of fatigue and exhaustion. Doubtless other environmental conditions, such as excessive or deficient light, noise, and gross mechanical vibrations, influence the fatigue process, but these have not been adequately and experimentally studied. Attention might here be called to the suggestive little book recently published by the Gilbreths, which shows by what easy and simple means unnecessary fatigue may often be avoided.

It is obvious that if, under any given conditions of intensity and rate of labor and of its environmental features, the working-day is of such a length as to bring about the evil physiological results here mentioned, the surest way to avoid them is to shorten it. There exist few, if any, studies devoted to the specific physiological effects of a reduction of the working-hours, and this gap in our knowledge it is desirable to fill; but that the general health of

laborers has thereby been benefited is testified to by many observers, and this is equivalent, in other words, to an improved physiological status among them.

The economic argument, that industry can thrive only with a long working-day and that any curtailment of it would be destructive, is perennial and has often been potent in discussion. This argument can be met very effectively by pointing to the effects of shortening the working-period on the quantity and quality of output in manufacture. These effects are so uniform that it may be stated as a general law that upon reduction of the daily hours of labor the average quantity of the output of the individual worker undergoes a preliminary decrease, then a return to the original amount, and finally a permanent increase. This augmentation of output occurs, not only with a reduction to ten, but even to eight, hours. Instances of this are numerous. Thus, the very careful study by Professor Abbe of the effects of reducing the working-day in the Zeiss Optical Works in Jena from nine to eight hours shows an average increase of about three per cent. in the daily output of the employees. A certain steel works in England reports that each of its machines turns out in eight hours the same amount of work formerly produced in nine hours. In the steel-sheet and tin-plate trades of South Wales it is stated that after the change from the twelve- to the eight-hour day the increase of output in the rolling-mills amounted to twenty, and in the open-hearth melting process to twelve and one-half, per cent. In the year following the introduction of the eight-hour day into some of the coal mines of South Yorkshire it was reported that the production was "greatly in excess of what was ever produced by an equal number of men when the men worked twelve or thirteen hours." In the mining of bituminous coal in the state of Illinois during the three years previous to a reduction, in 1897, of the working-day from ten to eight hours the average amount of coal turned out daily by each individual was 2.72 tons and during the subsequent three years 3.16 tons, an increase of 16 per cent. The president of a granite-cutting company which had kept for many years a careful record of each employee's work, writes in 1912 that the system

> shows that the same man under identically the same conditions, accomplished more, of exactly the same kind of work when he was working nine hours, than he did when he was working ten hours, and again when the hours were reduced to eight hours this same man accomplished still more in an eight-hour day than he did in a nine-hour day, or a considerable amount more than he did when the day was ten hours long.

A German proprietor of glass-works reports that in a very short time after the reduction of the working-day from twelve and eleven to eight hours "there was produced, without increase of staff, as much as before the reduction"; and a proprietor of glass works in the north of France says:

> I must acknowledge that the men produce just as much, if not more, in their seven and a half hours' actual work than during the ten-hour day that preceded it.

At the Engis Chemical Works near Liége, where a very exact study was made of the results of introducing the eight-hour day, it was reported that

> In an eight-hours' day (seven and one half hours' actual work) the same men at the same furnaces with the same tools and raw material have produced as much as before in a twelve-hour day (ten hours' actual work).

A very significant comparison of the effects of long and short hours was made in connection with the building in the same years of two of our battleships, the *Louisiana* and the *Connecticut*. The *Louisiana* was built at Newport News by a private company working its men ten hours a day; the *Connecticut* was built at the Brooklyn

Navy Yard under the eight-hour system. In a report on the progress of the work during the first nineteen months it is stated by the compiler:

> No other factor is considered than the productive ability of the two bodies of men doing exactly the same kind of work, using the same kind of tools and the same kind of material. It is practically all hand work, as the output of the automatic machines, with their speed limitations in production per hour, does not enter into this work.

The final computation showed that "the average production of a man per hour on the *Connecticut* exceeded by 24.28 per cent. the average production per man per hour on the *Louisiana*."

Thus, the statistics reveal the utter fallacy of the notion that a longer working-day means a larger output. But the greater product of the short day, is, I submit, at first thought a very surprising fact, and its cause should be inquired into. It undoubtedly rests on a physiological basis, but without more accurate data any explanation of it must be only tentative. If man were a mere non-living automatic machine it would not occur. But his is a very different mechanism, in which that portion which does work, the effector machinery, is directed by a nervous system, which acts now consciously, now unconsciously, and through its receptor machinery is being continually influenced by external stimuli. All employers testify to the increased good-will, better spirit, and improved morale of the workers, that result from the shorter day. Because of these things the workers arrive more promptly at their places and tend to shirk less as the day proceeds. It is not inconceivable that in many cases there is a residuum of fatigue accumulated from the previous longer working-period, which must first be gotten rid of, and that thereafter the effector mechanism is less clogged. It is not improbable that realization of the brevity of the day and the early relief from toil act as a tonic. Such tonics exist: The spurt that occurs during the last hour of labor, irrespective of its length, is a commonly alleged, if not an attested, fact, and is ascribed to anticipation of release. Careful observation has shown too that other psychic influences increase markedly the output of a man's energy. All these varied influences acting upon the nervous system doubtless contribute to increase the expenditure of productive energy in the shorter time. Their combined influence is largely unconscious, and it is reported that the greater output is often a surprise to the workers themselves. That it has an origin largely in the action on the nervous system of such external stimuli as have been mentioned, is supported by the further facts that with the eight-hour day the workman makes fewer mistakes and spoils less material, and, in general, the quality of his work shows a distinct improvement. Thus, in the light of the facts of experience, the alleged economic necessity of the longer working-period because of the necessity of a greater output falls to the ground. The long working-period defeats its own object.

But the question may still be raised whether the greater output of the eight-hour day does not produce correspondingly greater fatigue and thus in turn defeat its object. I do not think so. If the day's fatigue were measured merely by the amount of energy transformed in producing the product, if here again man were a mere automatic machine, then surely there would be a direct ratio—the greater the product, the greater the fatigue, and nothing would be gained. But the case is not so simple as this. The day's fatigue is a sequel not simply of the amount of energy directly transformed in producing the material output. It is derived also from other sources —from the continuance of one bodily position, perhaps a strained position, from the noise and gross vibration of machinery,

from strained attention, from all those minor factors which Abbe has grouped together as sources of his well-named "passive fatigue." A shorter day eliminates these by so much and at its end leaves the worker so much better off than his longer-laboring fellow.

The argument for shorter hours that is most frequently put forward, by labor leaders at least, is the social one. Thus, Mr. Samuel Gompers says:

> The shorter workday is something more than an economic demand. It is a demand for an opportunity for rest, recuperation, development; things which make life more than mechanical drudgery.

This is undoubtedly a legitimate demand, but it in turn is dependent on the physiological requirements of the labor. If a man is worked beyond his physiological limit he is incapacitated for his duties to his family and to society. The history of labor has demonstrated this abundantly, and the experience of reducing the hours of labor has almost universally been followed by marked moral and social improvement, such as is shown by decrease in intemperance and crime, improvement in living conditions, greater efforts toward education, greater intelligence and greater industrial efficiency—all this in contradiction, not only to the vivid predictions of disaster pronounced by active and unprincipled opponents of the change, but to the fears of those who were well-meaning but timid.

As possible factors in determining the duration of labor I might mention the degree of skill required by the laborer and the degree of responsibility devolving upon him. These may rightly be potent in determining the amount of wage to be paid, since they are the accompaniments of greater intelligence and the results of greater training; but in their bearing on the length of the working-day they can be considered, it seems to me, only in the light of their physiological demands on the laborer. If the exercise of greater skill and the possession of greater responsibility deplete his physical and mental powers more quickly, he has earned a shorter working-period. If they do not, I see no reason why he should be granted time privileges.

Let me here summarize. Of the various agencies that have been considered as legitimate factors in determining the length of the working-day that which appears to me the most weighty is the physiological one, the physiological effects of the labor on the individual laborer. In the pursuit of his vocation as the employee of another every human being has a right to the preservation of his physiological powers, to the avoidance of excessive fatigue, to the continuance of his health. All questions of the percentage of financial profit, all questions of social demands or social opportunity, are subordinate to this. Moreover, this is essential to the other considerations mentioned, for only by the preservation of his health can the economic demands of his work be satisfied, only by this can he acquire and maintain skill and be worthy of responsibility. The whole question of the length of the working-day thus rests primarily on a physiological basis. In deciding the length of the working-day, therefore, the first and all-important query is: Is a long day physiologically detrimental to the individual? If so, it should be shortened. If the long day is not physiologically detrimental, then it is a fair question whether, because of his employer's interests or his own relations to society, his day should be long or short.

Is the reduction of the working-period to the eight-hour day a physiological necessity? Here two factors are to be considered: The characteristics of the labor and the capacity of the laborer. Different occupations differ greatly in their fatiguing power. Especially productive of fa-

tigue are those that are characterized by great muscular effort; unusual quickness or complexity of muscular action; single acts, however simple, that are monotonously repeated over long intervals of time; constant strain in attention or bodily position; and those in which the work is carried on in excessively crowded places, in excessive heat and humidity, in the midst of excessive noise, or under other unfavorable environmental conditions.

While different occupations thus differ in fatiguing power, not only in themselves, but in accordance with the external conditions under which the work is performed, there exist also great differences among human beings in their susceptibility to fatigue from a given occupation. This also is paralleled by individual muscles in a familiar laboratory experiment: Homologous muscles from different experimental animals or even from opposite limbs of the same animal, when stimulated at the same rate and lifting equal loads, do not usually perform the same amount of work. In industrial work every observant foreman who knows his men recognizes their individual differences in working power.

Neither the fatiguing effects of the manifold varieties of labor nor the susceptibilities of different laborers to fatigue have been studied with the degree and the care that the subjects demand, and with such paucity of knowledge it seems hardly possible at present to attempt to answer the question whether the reduction of the working-period to eight hours is a physiological necessity. The universality of the beneficial effects of such a reduction, however, argues strongly in favor of an affirmative reply. There has been no more clear-sighted observer and more logically analytic thinker on this topic than the late Professor Abbe, of Jena, in whom the breadth of scholarly culture was combined with a keen sense of efficient business organization. Ten years ago, after carefully analyzing the results of the reduction of the working-day in the Zeiss Optical Works and elsewhere, and considering the general condition of German industries, with their then prevailing long, and English industries, with their short, working-day, Abbe came to the conclusion that by far the majority of industrial workers do not reach their optimum in nine, and do not surpass it in eight, hours. With him the shorter day represents the physiological ideal and the goal for which industries should strive.

I am disposed to agree in general with Professor Abbe's conclusion for the present day. But it is evident, I think, that such a conclusion offers merely a temporary expedient. The establishment of a rigid and universal eight-hour system would probably prove not to be the best for all industries and for all individuals. In order to enable the wisest decision of the question to be made there is needed not mere opinions—not the opinions of employers, however broad-minded or narrow-minded; or of laborers, however industrious or indolent; or of labor leaders, however generous or selfish their ambitions; or of the laity, however philanthropic their motives; or of statesmen, whether they are impelled by a high idealism or by practical politics; but a rigidly scientific study of the question, through the medium of laboratory tests, of the physiological effects of different occupations and the physiological capacities of different laborers and a resultant classification, on a physiological basis, of work and workers. Such a study is not impossible, and it would afford the only basis for a rational and really intelligent solution of the problem. It would doubtless lead to the establishment of no rigid, but an elastic system, in which the work would be adapted to the worker, and the worker to the work. In one industry the duration of labor might be eight hours,

in another it might be more or less than eight hours. So too within a single industry one worker might labor longer than another. Such a solution could be made to satisfy both economic and social demands and lead to the maximum of individual and national efficiency.

I quite realize the difficulties inherent in putting into practise a system which does not recognize the magic eight hours as the ideal, and especially the still greater difficulties in the establishment of a system in which within a single occupation one person works longer than another. But I believe that these difficulties would prove less formidable if we would once get accustomed to the notion that individual capacity is the first criterion to be considered in deciding upon labor's duration. The adjustment of wages according to individual capacity I will leave to the economists.

In view of all this how fatuous was the action of the state of California in voting, in 1914, on the question whether the eight-hour day should be adopted! The proposition was defeated by about two to one, but the decision was necessarily a matter of sentiment, resting on no basis of adequate knowledge. An affair of such serious moment ought not to be decided by uninstructed popular feeling. The recent action of Congress in imposing, after a few hours' consideration, an eight-hour day upon railway employees can hardly be called more sagacious than the action of California. The Adamson bill, however, has little bearing on the general principle of the eight-hour day.

It is obvious that any formal regulation of the duration of daily labor is for those whose daily services are employed by others. By so much as a man rises above this stage he becomes free to choose his own working-time. It is a noteworthy fact that with the world's leaders, in industry, in finance, in professional life, the duration of the daily task is wholly secondary to its accomplishment. They are limited by no eight-, or ten-, or twelve- or sixteen-hour considerations. This indicates why such men become leaders. Laborers can learn a valuable lesson from this fact. The greedy employer who constantly saps the energies of those who are the medium by which he gains his wealth is to be condemned no more than is the "slacker" whose only guiding principles are a minimum of effort and a maximum of wage. Moreover, it is trite to say that the obligation rests upon the laborer that rests upon all men, so to use his free hours as to benefit himself, his family and society.

In conclusion I can not refrain from quoting, with warm approval of their sentiments and of their application to our own country, the recent significant words of Sir George Newman regarding British industries:

> Our national experience in modern industry is longer than that of any other people. It has shown clearly enough that false ideas of economic gain, blind to physiological law, must lead, as they led through the nineteenth century, to vast national loss and suffering. It is certain that unless our industrial life is to be guided in the future by the application of physiological science to the details of its management, it can not hope to maintain its position hereafter among some of its foreign rivals, who already in that respect have gained a present advantage.

FREDERIC S. LEE
COLUMBIA UNIVERSITY

THE CARE OF PAMPHLET COLLECTIONS[1]

THE published articles pertaining even to the most restricted fields of science are scattered through a very large number of serial publications of which only the larger institutions of learning and research are able to possess complete sets. The high cost and large bulk of such series preclude their being owned

[1] Contribution from the Museum of Vertebrate Zoology of the University of California.

by individual investigators or by the smaller institutions, and the general result is that the worker who desires to cover the literature of his particular field must have access to a collection of reprints and excerpts of such articles, gathered either independently, or by the institution with which he is connected. Thus most investigators have occasion to assemble and care for a pamphlet collection. The present paper considers some of the expedients commonly employed for this purpose and calls attention to a particular scheme which has been found satisfactory in the care of one collection.

Before a pamphlet collection can be efficiently used it must be properly arranged. The time thus spent will bring ample return in the added facility with which particular papers can be located when they are desired. In addition to this the exercise of a few simple precautions will do much to prolong the life and increase the usefulness of the pamphlets in a library. Dust, strong light and careless handling all help to depreciate the value of pamphlets. As time goes on and by one means or another, the copies of certain papers decrease in number; those which remain inevitably increase in value and become more difficult to obtain. It is needless to insist on the advisability of arresting these losses.

The methods in use for assorting and conserving pamphlets are various. Some collections are arranged to satisfy special needs, while others have no further purpose in their organization than that of general convenience. A popular method is to keep the reprints in flat piles on shelves. This, however, does not permit ready location, and removal of single papers from the pile involves a risk of tearing either them or the sheets adjacent to them. A second device is to place the pamphlets vertically on a shelf. This makes it possible to remove any desired paper without disturbing those adjacent to it. But unless there are frequent vertical partitions for support, the pressure exerted by the weight of the papers on either side makes the removal of thin pamphlets difficult. Both of these methods expose the collection to light and dust. A third method is to bind the pamphlets in volumes. This obviates the danger of damage by light or dust, but is still open to several serious objections. Chief among these is the difficulty of arranging the papers in a thoroughly convenient manner for ready reference. Of course where there are a number of papers by a single author these may be readily bound together chronologically in one or more volumes, but where the assortment is varied the problem of assembling for binding is more complex. All of the papers of one author may not be on hand when the binding is done; the contents of bound volumes can not be so readily indexed as can separate papers; and the papers contained therein can not be so easily laid out for study as when separate and unbound. A final objection to binding is that it involves considerably more expense than most of the other modes of filing.

A fourth method is to place the pamphlets in vertical filing cabinets. This economizes space as regards depth more than any of the other systems here mentioned but the cost of the containers is quite high—ranking close to or above that of binding the papers in volumes, according as the cabinet selected is of the rough "transfer" or highly finished type.

The last plan we shall notice is one that is probably in more general use than any other, namely, placing the pamphlets in narrow pamphlet cases. These are of three general types. The first resembles a small letter file with a hinged back which completely protects the contents from dust and light. This case is heavier and much more expensive than the others and is slightly more inconvenient to handle because of the necessity of opening the back when removing the contents. The second type has both top and back open and while it will accommodate pamphlets of widely different sizes it exposes portions of the papers to the harmful action of dust and light. The third type, a box open only at the back, seems by far the most convenient, as when pushed against a wall it is practically dust and light proof, though still permitting ready reference to its contents. Cases 12 inches high, 8 inches deep and $2\frac{1}{2}$ inches wide, made of a

good weight of strawboard faced on the inside with white paper and entirely covered on the outside with black binder's cloth, have been found to give excellent results. These seem even more durable than cases with wooden tops and bottoms, as they have a slight "give" which seems to make them more lasting. A set of cases of this sort has been in constant use at the Museum of Vertebrate Zoology of the University of California for more than six years without showing appreciable wear. The size suggested will take all octavo publications and even the smaller quartos, and when completely filled the weight is still not too great for easy handling. Cases measuring more than 2½ inches in width are not satisfactory; they soon break to pieces under pressure of the greater weight of the material they hold. They often, moreover, hold too many papers for quick reference, while the narrower boxes permit of a finer classification. With the smaller size additional boxes may be interpolated as necessity arises, before a complete revision of the collection is required.

Three methods of filing the pamphlets of a collection are in general use; filing by subject, by author's surname, and by date of accession. For a small collection with which the worker is well acquainted and where there are few if any papers of such a nature as not to fall readily into one class or another, or in very large collections comprising papers on such distinct subjects as geography, geology and zoology, the subject classification is possibly the most convenient. But in large collections devoted to a narrower field the alphabetical segregation by authors is much more satisfactory. With papers so arranged and those of single authors in chronological order, no author index is needed. A third system, used somewhat more rarely, is to file pamphlets in the order of their receipt, giving them serial numbers, and maintaining both author and subject indexes for reference purposes. Such an arrangement has the advantage of not being disturbed by later accessions, these being added at the end of the collection. Under this system, however, the papers must be kept absolutely in order if they are to be found at all.

If cases are used to shelter the collection, some kind of case inscription is necessary, whatever system is adopted. When the cloth-covered cases described above are used, pieces of white paper, about 1¾ inches square, are pasted on the fronts of the boxes near their tops. On these labels are placed inscriptions designating the case contents. If the subject arangement is used, the title is made comprehensive enough to include all papers which are or may be filed in that case. If the author classification is used, a large initial letter is placed at the top and below it abbreviations indicating the names of the authors whose papers are filed in that case. Thus, for the case containing papers from Brown to Burns the inscription would be

B·
Br-Bu.

If one author's papers are sufficiently numerous to require one or more complete cases their fronts bear his initial and name and an indication of the years covered by the papers included, thus:

O	O
Oberholser, H. C.	Oberholser, H. C.
1905–1914	1914——

When first arranging or when revising the arrangement of a pamphlet collection, sufficient room should be left in individual cases to anticipate considerable expansion—no case should be more than two thirds filled at first, save for a single author, unless the collection is already large and the expense of additional cases is an object for consideration. Thus a large number of papers can be added to the collection before it need be completely revised and relabelled.

Whatever method of arrangement is adopted some sort of finding index is necessary to make all the papers readily accessible. If any system other than that of filing by authors' names is adopted a catalogue of authors is needed. If the subject classification is adopted a card should be used for each author, the entries being made as follows:

Ridgway, R.
1892. Hummingbirds (Aves: systematic)
1897. Galapagos Is. birds (Faunal: S. Amer.)

The words in parentheses indicate where the paper is filed. When papers are filed by the accession method the same sort of entries are made in the author catalogue save that the serial number of the paper is included in the parentheses at the right. Thus:

Ridgway, R.
1892. Hummingbirds (642)
1897. Galapagos Island birds (1489)

Where papers are arranged by authors a subject index only is needed. For example, in the writer's own index for papers in vertebrate zoology there are included cards for systematic, and for geographic or faunal entries. Many papers require entry under both headings and some under even more. Thus, a paper by Ruthven, Thompson and Thompson, entitled "The Herpetology of Michigan," would be entered under "Reptiles," "Amphibians" and "Michigan." In this way the paper can be found under any of the three titles carded. The form of subject index entries is indicated by the following samples:

Reptiles
nw. Nevada—Richardson 1915
Michigan—Ruthven et al. 1912
San Jacinto Mts., Cal.—Atsatt 1913
Deer
Situation in Calif.-Clarke *in* Cal. F. & G. Comm. 1913
Farming in U. S.—Lantz 1914
Colorado River
Fishes—Gilbert and Scofield 1898
Birds and mammals—Grinnell 1914 (review Sumner 1915)

Papers often occur which are difficult of exact classification and it is well to have general headings under which these may be included, as for example "Birds," "Mammals," "Variation," etc. These titles may be subdivided, as the papers accumulate.

For all indexes the standard sized 3 by 5 inch cards of librarians and bibliographers are the most suitable. In entering the references a carbon ink such as Higgins Eternal is recommended because of its permanency of color and the uniformity of entries made at different times.

As a result of the great variation in the manner of placing the title, author's name and date of publication on the covers of reprints or pamphlets considerable time is lost in searching for these items when looking through a file. An easy way of overcoming this difficulty is to annotate the upper left-hand corner of the front of each paper with the author's name and initials, the date, and a catch title, in the form used by Professor E. L. Mark, of Harvard, thus:

Ruthven, A. G., et al.
:12
Herpetology of Michigan

Rutter, C.
:08
Sacto.-San Joaquin Valley Fishes

Ridgway, R.
:92
Hummingbirds

The catch titles are arranged so that in looking down the left-hand margin the eye encounters the most important words first. With pamphlets so marked only a few seconds are required to secure any particular paper and it is often possible to locate it without removing the others from the case. Where there are a number of papers by a single author it is well to number them serially beginning with the oldest one. Then when a paper is withdrawn it can be quickly and correctly replaced by its number without having recourse to the date. For these annotations, as with catalogue cards, carbon ink should be used. Another method which has been used for the same purpose as these corner annotations is to underscore the author's name, the date and the title.

Serial publications are best kept in sets by themselves as they are received, but where the individual articles comprising a volume are issued in separate form these may be run into the general collection along with other pamphlets. Later on they can, if desired, be removed and bound in complete volumes. The writer has a considerable number of pamphlets relating to subjects outside his main line of work but which for one reason or another he desires to keep. These are arranged according to the names of their authors, and kept in a "reserve" file, where they can be

easily located. Many of them are complementary parts of complete volumes, the other papers of which are in his main pamphlet collection.

The date of receipt should always be written on the pamphlet as soon as it comes to hand. With some series no date of publication is given on the separate papers, and as they may have been issued in advance of the appearance of the complete volume, it often becomes important to know their dates of receipt, as in the case of papers describing new species of animals or plants.

In summary, then, the writer would recommend that a pamphlet collection be placed in cloth-covered cardboard cases open only at the back and not larger than $12 \times 8 \times 2\frac{1}{2}$ inches, that it be arranged alphabetically by authors' names and chronologically under authors, that the corner of each pamphlet be annotated with the author's name, the date, and a catch title, and that a subject index be maintained to facilitate the location of particular pamphlets. A collection so arranged and housed renders the greatest amount of service, and is reasonably insured against deterioration.

TRACY I. STORER

BERKELEY, CALIFORNIA

THE BRAIN COLLECTION OF THE U. S. NATIONAL MUSEUM

THE division of physical anthropology of the United States National Museum has been recently enriched by a most valuable accession of brains of some of the higher anthropoids. The accession consists of no less than eleven well-preserved brains of gorillas, and three chimpanzees. With the exception of two of the specimens belonging to young animals, the brains are in excellent condition for study. No less than six of the fourteen brains are those of adults, while most of the remaining, though not quite adult, are full-grown or nearly so.

A justifiable allusion may perhaps be made in this place to the rest of the collection of primate brains now in the division of physical anthropology, U. S. N. M.

The total collection, which was started by the writer thirteen years ago, counts now approximately 1,500 human and animal brains. Of these 223 are human, including 128 of other races than whites; while 348 belong to other primates. The latter are distributed as follows:

Gorilla	11	(5 adults)
Chimpanzees	6	(1 adult)
Orangs	36	(23 adults)
Gibbons and siamangs	55	(most adults)
Nasalis larvatus	17	" "
Baboons	22	" "
Presbytis	75	" "
Other Old World monkeys	64	" "
American monkeys	45	" "
Lemurs	17	" "

A large proportion of the above valuable material has been collected directly in or for the institution, and is in a very good condition for study. The number of adult anthropoid brains, excepting those of the chimpanzees, exceeds probably that of all other known collections of similar material not only singly, but even collectively.

Besides those of the primates, there are now in the collection the brains of 165 *carnivora* and *cetacea;* 50 *insectivora;* 266 *ungulata;* 81 *rodentia;* 47 *edentata* and *marsupialia;* and 287 *aves* and *reptilia.*

The whole collection, in common with others in the division and in the U. S. National Museum in general, is freely accessible for consultation to well-qualified scientific workers; and in suitable cases facilities could be extended for full elaboration and description of some of the series of specimens.

ALEŠ HRDLIČKA

PROGRAM OF THE YALE CHAPTER OF SIGMA XI FOR 1916–1917

THE meetings of the Yale Chapter of Sigma Xi for the present college year promise to be of unusual interest, for there are to be presented, instead of the usual mutually irrelevant papers, a series of lectures which together will constitute a symposium on the origin and evolution of the earth and its inhabitants. Each paper will be authoritative, the result of original research, and the series

after presentation is to be brought out in book form by the Yale University Press. The program follows:

I. The Genesis of the Earth. Professor Joseph Barrell. November 23.
II. The Earth's Changing Surface and Climate. Professor Charles Schuchert. December 13.
III. The Origin of Life. Professor Lorande Loss Woodruff. January 24.
IV. The Pulse of Life. Professor Richard Swann Lull. February 15.
V. Climate and Civilization. Dr. Ellsworth Huntington. April 20.

Thus there will be discussed: (1) The genesis of the earth and the rise of conditions necessary for the maintenance of life; (2) the surface changes, the great cycles of climatic change, and their cause or causes; (3) the origin of organic life on earth, the time, place and conditions necessary, and the changes undergone by matter to render it organic or possessed of life; (4) the march of organic evolution, not a slow process progressing at a constant rate of change, but rhythmic, the pulses or times of acceleration being coincident with and the direct outcome of the climatic and geologic changes already described. This includes the origin of man from his prehuman ancestry. (5) The recent climatic changes whose existence has been traced and recorded and which are found to have influenced the growth of civilization, the rise and migrations of peoples, and in some instances their fall from an estate of commanding importance. A prophecy of human destiny may here be given.

These lectures are to be given at the regular meetings of the society and therefore will not be open to the general public, but are to be the especial privilege of the members of Sigma Xi and a limited number of their friends to whom tickets of admission will be given. The lectures are to be held in Osborn Memorial Laboratory.

THE ENDOWMENT OF A MEDICAL SCHOOL AT THE UNIVERSITY OF CHICAGO

A correspondent at the University of Chicago sends us the following information concerning the endowment of a medical school noted in the last issue of Science:

In outlining the plans and hopes of the University of Chicago at its recent quarter-centennial celebration President Harry Pratt Judson said that what was needed to complete a school of medicine at the university was provision for clinical work and a clinical staff at the Midway, and that in his judgment the first need was for a hospital wholly under the control of the university, for medical teaching and for medical research; and the second need was provision of adequate endowment, in order that the hospital itself might be beyond the necessity of being financed by income from its patients, and in order that the medical faculty might be free to pursue their work of investigation and instruction without recourse to personal practise.

In direct fulfilment of this hope and plan, the university board of trustees has just made one of the most important announcements in the history of the institution. The plan announced to be put into early operation provides for an undergraduate medical school, a graduate medical school and medical research. The first mentioned will be on the Midway Plaisance, in close connection with the science departments of the university. The standards of admission and of graduation will be as high as those of any medical school in the country. The number of students will be limited to such as can receive the best possible training with the facilities available.

A teaching hospital, duly equipped with necessary laboratories and lecture rooms, will provide for clinical instruction. Suitable endowments will free the hospital from the necessity of depending on paying patients, and the faculty from the necessity of practise for a livelihood.

The graduate medical school will be on the west side in connection with the work now done by the Rush Medical College and the Presbyterian Hospital. It will provide for medical graduates who wish further training and for practitioners who wish to keep in touch with progress in medical science. Research will be carried on in both places under arrangements to be announced later.

The plan involves an addition to the resources of the university of the sum of five million three hundred thousand dollars, one million for the hospital on the Midway, three hundred thousand for a laboratory on the west side and four millions for endowment.

Towards the endowment fund the Rockefeller Foundation offers one million dollars and the

General Education Board one million dollars, provided the entire sum of five million three hundred thousand dollars shall be raised. Further pledges of individuals have been made to the amount of seven hundred thousand dollars. Thus two million seven hundred thousand dollars have already been secured. Two million six hundred thousand dollars remain to be secured and in the near future a campaign will be initiated to complete the fund.

In speaking of this announcement, which is probably the most significant that has ever been made in connection with higher medical education in Chicago, President Harry Pratt Judson says: "The medical plans which have just been announced represent many years of hoping and working and dreaming. These plans, we think, will not merely be, when carried out, a great addition to the resources and power of the university, but will render a very valuable service to Chicago, and to the cause of medical teaching and investigation in the entire country."

A later announcement is just made that half a million dollars toward this new medical fund for the University of Chicago has been given by Mr. and Mrs. Julius Rosenwald, of Chicago. Mr. Rosenwald, who is a trustee of the university and donor of the new Julius Rosenwald Hall devoted to the work of geology and geography, is one of the university's most generous and loyal friends; and Mrs. Rosenwald, who shares in this great gift, is widely known for her practical and constant sympathy with many movements for social and artistic advancement in Chicago.

At the meeting of the board of trustees of the university on November 14, the following committee was named to conduct the campaign for funds: President Harry Pratt Judson, chairman; Adolphus C. Bartlett, Dr. Frank Billings, Thomas E. Donnelley, Andrew MacLeish, Martin A. Ryerson, Julius Rosenwald, Robert L. Scott and Harold H. Swift.

THE COUNCIL OF NATIONAL DEFENCE

PRESIDENT WILSON announced recently the appointment of the members of the advisory commission to be associated with the Council of National Defence created by congress at the last session. The seven men named are: Daniel Willard, president of the Baltimore and Ohio Railroad; Samuel Gompers, president of the American Federation of Labor; Dr. Franklin H. Martin, of Chicago; Howard E. Coffin, of Detroit; Bernard Baruch, of New York; Dr. Hollis Godfrey, of Philadelphia, and Julius Rosenwald, of Chicago.

A statement by the President in connection with the announcement follows:

The Council of National Defence has been created because the congress has realized that the country is best prepared for war when thoroughly prepared for peace. From an economic point of view there is now very little difference between the machinery required for commercial efficiency and that required for military purposes. In both cases the whole industrial mechanism must be organized in the most effective way.

Upon this conception of the national welfare the council is organized in the words of the act "for the creation of relations which will render possible in time of need the immediate concentration and utilization of the resources of the nation."

The organization of the council likewise opens up a new and direct channel of communication and cooperation between business and scientific men and all departments of the government, and it is hoped that it will in addition become a rallying point for civic bodies working for the national defence.

The council's chief functions are:

1. The coordination of all forms of transportation and the development of means of transportation to meet the military, industrial and commercial needs of the nation.

2. The extension of the industrial mobilization work of the committee on industrial preparedness of the naval consulting board. Complete information as to our present manufacturing and producing facilities adaptable to many-sided uses of modern warfare will be procured, analyzed and made use of.

One of the objects of the council will be to inform American manufacturers as to the part which they can and must play in national emergency. It is empowered to establish at once and maintain through subordinate bodies of specially qualified persons an auxiliary organization composed of men of the best creative and administrative capacity, capable of mobilizing to the utmost the resources of the country.

The personnel of the council's advisory members, appointed without regard to party, marks the entrance of the non-partisan engineer and professional man into American governmental affairs on a wider scale than ever before. It is responsive to the increased demand for and need of business organization in public matters and for the presence there of the best specialists in their respective fields.

In the present instance the time of some of the

members of the advisory board could not be purchased. They serve the government without remuneration, efficiency being their sole object and Americanism their only motive.

SCIENTIFIC NOTES AND NEWS

The University of Iowa at the last commencement bestowed the degree of doctor of laws upon Professor J. C. Arthur, emeritus professor of botany in Purdue University. In the presentation made by Mr. D. D. Murphy, president of the State Board of Education, the services of Dr. Arthur to pure and applied science were reviewed. Special emphasis was placed on his contributions to agriculture and horticulture in the study of plant diseases. This work began when, as the first botanist in an American experiment station, pear blight was investigated, and may be said to have culminated in the discovery of formaldehyde as a fungicide, especially for diseases of potatoes and grains. Studies on the relation of weeds to effective cultivation resulted in new methods for their control and extermination. His work in physiological botany, and his fundamental studies in mycology, have given occasion for the introduction of new technical terms, which have entered into general use. Other matters pertaining to the long and eminent services of Dr. Arthur were touched upon by President Macbride in conferring the degree.

Alumni of the department of geology and geography of the University of Chicago have presented to the university a portrait of Professor Rollin D. Salisbury, head of the department of geography and dean of the Ogden School of Science. The portrait, recently finished by Ralph Clarkson, the Chicago painter, is now at the Art Institute and will later have a permanent place in the new Julius Rosenwald Hall at the University of Chicago.

Professor M. Pasch, who holds the chair of mathematics at the University of Giessen, celebrated the fiftieth anniversary of his doctorate on August 21, 1915. On this occasion the University of Breslau renewed his diploma.

The Bakhuis Roozeboom medal has been awarded to Professor Schreinemakers, professor of inorganic and physical chemistry in the University of Leyden.

Dr. M. O. Forster, who was elected as a prospective Unionist candidate for parliament, has resigned. He is engaged in assisting the state-aided organization for producing dyes, work which absorbs all his time, and in the letter of resignation he says that the energy and resources of those occupied in the British dye industry must, if possible, be increased on the advent of peace.

We learn from *Nature* that the Chinese government has appointed as the head of a geological survey, Dr. J. G. Andersson, formerly chief of the Swedish Geological Survey, and with him already are Dr. Tegengren and Professor U. Nyström. Dr. T. G. Halle, assistant in the paleobotanical department of the Riksmuseum at Stockholm, is to travel in China for one year, mainly in the interests of his own department, for which he will collect paleozoic plants, but partly for the Chinese government, to which he will report on the age and character of the coal-seams inspected, and for which a duplicate series of fossils will be provided after their determination. A young Chinese geologist will accompany Dr. Halle, and will be trained by him as a paleobotanist.

Mr. Julius Lemkowitz, during the past year computer in the Yerkes Observatory, has gone to Princeton as observatory assistant.

Harvard University has granted a leave of absence for the second half of the academic year, 1916–17, to Professor W. C. Sabine, Hollis professor of mathematics and natural philosophy.

Mr. Roy Chapman Andrews, in charge of the American Museum's Asiatic zoological expedition, reports that nearly two hundred mammals and four hundred birds have been collected in the vicinity of Foochow, in the province of Fu-kien. Mr. Edmund Heller has joined the expedition, which on August 10 was on the way to Yunnanfu, to make collections in Yunnan Province.

Professor W. B. Scott, of Princeton University, gave an illustrated lecture on "The Relations of South America to other Conti-

nents, especially North America," in the geological lecture room of Harvard University on November 15.

THE lecture course of the Washington University Association for 1916–17 opened this year with an illustrated lecture by Dr. H. M. Payne, of New York, formerly dean of the Missouri School of Mines and Metallurgy, on "The Gold Fields of Alaska and Siberia."

THE Worcester Polytechnic Institute held a memorial service for the late Dr. Levi L. Conant, professor of mathematics, in Central Church, on November 19. The faculty and students attended in a body. The speakers were Hon. Charles G. Washburn, president of the board of trustees; Professor Z. W. Coombs, representing the faculty; Mr. C. H. Dwinnell, vice-president of the First National Bank of Boston, representing the alumni, and particularly the class of '94, with which Professor Conant began his work at the institute; and Dr. Homer P. Lewis, superintendent of the Worcester schools, representing the school board, of which Dr. Conant was a member for nine years.

THE late Professor Clinton DeWitt Smith was the organizer and first director of the Agricultural College of Brazil, the first of its kind in that country. The present director writes that in token of grief for Professor Smith's death the college was closed for two days and the flag was draped in mourning and hoisted at half-mast.

WE learn from *Nature* that Lord Rayleigh presided at the meeting held at University College, London, on October 31, to take steps to establish a memorial to the late Sir William Ramsay. Mr. J. A. Pease, M.P., postmaster-general, in moving that a memorial fund should be raised, to be utilized in promoting chemical teaching and research, under a scheme to be approved hereafter, said he was glad on behalf of the government to pay a tribute to the memory of Sir William Ramsay and to take part in the great object of the meeting. The memorial should be not merely national, but international. Sir J. J. Thomson seconded the motion, which was supported by the Belgian Minister, who wished to convey the respectful homage of Brussels University, and by Mr. W. H. Buckler, who testified to the interest of the American Ambassador and his countrymen in the movement. The resolution was carried. It was also agreed that the meeting should resolve itself into a general committee, with Lord Rayleigh as chairman, to raise the necessary fund, and an executive committee was appointed to circulate an appeal.

DR. PERCIVAL LOWELL, director of the Lowell Observatory at Flagstaff, Arizona, which he established in 1894, died of apoplexy on November 12, aged sixty-one years.

DR. WALTER S. SUTTON, professor of surgery at the University of Kansas, died at his home in Kansas City, Kansas, on November 10. He was known to biologists for his service in pointing out the mechanism in the germ cells for Mendelian inheritance.

CHARLES ELLERY AVERY, at one time instructor in the Massachusetts Institute of Technology and later professor in the Massachusetts College of Pharmacy, known for his invention of the process of manufacturing lactic acid, has died, aged sixty-eight years.

CHARLES FRANCIS ROPER, to whom was due important inventions on automatic screws and in other directions, died on November 14, at the age of sixty-seven years.

S. B. MACLAREN, professor of mathematics in University College, Reading, died on August 14, from wounds received in battle.

THE death is also announced, at the age of fifty-two years, of Dr. David Maron, a Russian research chemist who had been resident in England for many years, as the result of an explosion in a munition factory in London, where he was carrying on experiments in the manufacture of high explosive shells.

MR. M. W. DOMINICK has arranged to equip and endow the new medical library of the New York Medical College and Hospital for Women. Mr. Dominick offers this library as a memorial to his son, Dr. George Carleton Dominick, who recently died at sea. Dr. Dominick served the college for several years as lecturer and instructor.

A PLAN for the employment of the Sage Research Fund of the Medical College of Cornell University has been adopted. This fund of $50,000 was bequeathed to the university by Mrs. Sarah Manning Sage, widow of Dean Sage, for research in medicine. The plan adopted provides that a yearly appropriation from the income of the fund shall be administered by a committee composed of the president of the university and the heads of the departments that will participate in the fund; that a minimum be assigned by this committee each year to each of the departments; that a reservation be made for a specific research, and that each participant make an annual report. By action of the board there is an appropriation of $1,500 available for 1916–17.

THE Lee Museum of Biology at Bowdoin College has been given a collection of Hawaiian ferns by John A. Cone, Topsham; a gift of shells and mounted birds by Mrs. John S. Towne, Brunswick, and the Rev. H. W. Winkley, Danvers, Mass., has added to his previous gift of New England shells. Leland C. Wyman has been appointed custodian of the collections of fossils and fishes.

AT the invitation of the state geologist of Florida a conference of geologists and anthropologists was held at Vero, Florida, from October 23 to 30, the object of the meeting being to examine the locality near that place from which fossil human remains have been obtained. Those present at the conference were Dr. George Grant MacCurdy, Yale University; Dr. A. Hrdlička, U. S. National Museum; Dr. T. W. Vaughan, U. S. Geological Survey; Dr. O. P. Hay, Carnegie Institution; Dr. R. T. Chamberlin, University of Chicago; E. H. Sellards and H. Gunter, Florida Geological Survey; and I. M. Weills and Frank Ayers, of Vero.

WE learn from the *Journal* of the American Medical Association that a South American Society for Microbiology, Pathology and Hygiene was organized at the National Medical Congress held at Buenos Aires in September. The new society is to publish a review at Rio de Janeiro and at Buenos Aires, in Spanish, Portuguese, French, English and German. The editorial staff consists of R. Krauss, director of the Bacteriologic Institute of Buenos Aires, and O. Cruz, director of the similar institution in southern Brazil and formerly chief health officer of Rio de Janeiro.

THE magnetic survey vessel, *Carnegie,* left San Francisco, on November 1, on her homeward cruise of about 31,000 miles. She will make stops at Easter Island, Buenos Aires, Bahia, Porto Rico and return to Brooklyn in the fall of 1917. She has been gone on her long circumnavigation cruise since March, 1915, during which she has been in command of J. P. Ault of the Department of Terrestrial Magnetism.

THE German Ophthalmologische Gesellschaft has divided between Lindner of Vienna and Ohm of Bottrop the von Graefe-von Welz prize for the best article published in 1911–1913 in the *Archiv für Ophthalmologie.* Their articles were on trachoma and inclusion blennorrhea, and on miner's nystagmus.

THE *Observatory* remarks: "The sending of most kinds of printed matter from Britain to neutral countries (except by duly licensed publishers and booksellers) is now prohibited, and many astronomers must have wondered whether reprints of astronomical papers, reports of observatories, etc., which are usually posted privately, come under the ban. We have ascertained that these *may possibly* arrive at their destination, provided the full name and address of the sender is on the envelope; but they are liable (and quite likely) to be stopped. We may add that slip proofs sent for correction can be sent as usual. Also (for our foreign readers) that we duly receive scientific papers sent to this country from abroad."

REPLYING to a question raised in the British House of Commons, Mr. Forster stated that up to August 25, 1916, 1,501 cases were finally diagnosed as typhoid fever amongst the British troops in France, 903 amongst inoculated men and 508 amongst uninoculated men. There were 166 deaths, 47 of which were amongst the inoculated and 119 among uninoculated. To the same date there were 2,118 cases of paratyphoid fever, 1,968 amongst in-

oculated men, and 150 amongst men who had not been inoculated. There were 29 deaths—22 of which were amongst the inoculated and seven amongst the uninoculated.

THE Jesup lectures of the American Museum of Natural History are being given this year by Dr. R. S. Woodworth, of Columbia University, who has taken as his subject "Dynamic Psychology." The separate subjects and the dates of the lectures, which are on Friday evenings at 8:15, are as follows: November 10, The Modern Movement in Psychology; November 17, The Problems and Methods of Psychology; November 24, The Native Equipment of Man; December 1, Acquired or Learned Equipment; December 8, The Factor of Selection and Control; December 15, The Factor of Originality; December 22, Drive and Mechanism in Abnormal Behavior; December 29, Drive and Mechanism in Social Behavior.

DR. HERMAN M. ADLER, assistant professor of psychiatry, Harvard University, has commenced a study of the facilities for dealing with mental diseases and mental deficiency in Cook County, Illinois. The survey is under the general direction of the National Committee for Mental Hygiene and the expenses will be met by a special appropriation made by the Rockefeller Foundation. At the request of governors of the states, state boards of control, state boards of charities and social or civic organizations, the National Committee for Mental Hygiene has conducted or is at present undertaking such studies in Tennessee, Wisconsin, South Carolina, Louisiana, California, Connecticut, Georgia and Texas. The mayor and the board of estimate of New York City have seen growing up in their community a number of unorganized attempts to deal with what are apparently different phases of the same problem and within a few weeks a special committee has been appointed by the mayor consisting of the commissioner of accounts, the commissioner of public charities, the commissioner of corrections, the chairman of the parole board and the presiding justice of the children's court, to present a constructive plan for the examination, classification and proper treatment of mental defectives. The mayor's committee has requested the National Committee for Mental Hygiene to make for it such a survey as the study about to be commenced in Chicago. Thus studies of the same subject will be carried on simultaneously under the same general direction in the two largest cities of the country.

THE annual meeting of the American Social Hygiene Association and joint conference with the St. Louis Social Hygiene Society and Committee of One Hundred of St. Louis was held in St. Louis, November 19 to 21. The chief subjects for discussion were "The New Public Conscience," "Health Aspects of Social Hygiene," "Ways and Means of Public Education regarding Social Hygiene" and "Repression of Commercialized Vice."

THE orthopedic department of the Children's Hospital, Boston, will offer a course, beginning on December 1, 1916, in muscle training and in the principles of the nursing aftercare of infantile paralysis. This course will be open to a limited number of properly qualified women and will be an all-day course covering a period of about six weeks, most of the work being in the clinics and practical in character. The course will be under the general supervision but not under the actual instruction of Dr. R. W. Lovett, surgeon to the hospital to whom application for admission should be made.

THE Peabody Museum of Harvard University has received from Arthur Bowditch, Jr., '03, a large collection of spears, household articles and wearing apparel of the Bagoba, Manoba, Moro and other tribes of the Philippine Islands. The collection was made by him in 1914.

THE botanical collections of Mr. S. B. Parish, comprising over 50,000 herbarium sheets, have been purchased by Stanford University. Mr. Parish has devoted about forty years to the flora of southern California, and his herbarium contains the most complete collection of plants from that region that has been brought together.

Stanford University, with the cooperation of Dr. N. L. Britton, director of the New York Botanical Garden, has arranged to finance the publication of an Illustrated Flora of the Pacific Coast. Dr. LeRoy Abrams will edit the work, with the assistance of a number of the leading American botanists as collaborators. The flora will comprise four volumes containing illustrations and descriptions of every species of ferns and flowering plants on the Pacific coast.

At a meeting of the council of the National Museum of Wales, held at Cardiff, on October 28, it was announced, according to *Nature*, that a sum of £10,000 had been received from Capt. W. R. Smith, senior partner of the firm of W. R. Smith and Son, Cardiff, and Mrs. Smith, towards the building fund of the new museum. The donors had made this gift in the belief that the National Museum would be one of the first educational influences in the principality. There were other donors, who wished to remain anonymous for the present, and it is expected that when the present contract has been paid there will be a balance of about £16,000 towards the £50,000 which is needed to complete the furnishing and equipment of the portion of the building at present in course of erection.

The Embar formation of Wyoming is known chiefly for its extensive phosphate beds, which are supposed to have been derived in some manner from animal remains. The rocks contain abundant fossils, many of which are phosphatic, and all of which prove that the Embar beds of western Wyoming were deposited in the sea. Recent study of the eastward extension of the Embar formation in Wyoming shows that along the east margin of this ancient sea, or throughout the Bighorn Mountain region, the climate was probably more arid than that of any part of Wyoming to-day. By long evaporation beds of gypsum were deposited at some places in arms of this sea to a thickness as great as 100 feet. It is a question of practical importance whether beds of salt, and perhaps of potash salt, may also have been deposited in this formation and whether they may now be found below the surface. The United States Geological Survey, Department of the Interior, urges that oil men, in drilling through the Chugwater and Embar red beds in Wyoming collect samples of drillings and of brines and submit them to the survey for examination as to their possible potash content.

UNIVERSITY AND EDUCATIONAL NEWS

At the meeting of the trustees of the Carnegie Foundation for the Advancement of Teaching, held in New York on November 15, the proposal to make the pension system contributory was considered and action was postponed. This was the recommendation of the committee of the American Association of University Professors which was represented at the meeting of the trustees by Professor Edwin R. A. Seligman, vice-president of the association, and Dean Harlan F. Stone, chairman of the committee that drew up the report on the subject. The proposed plan of contributory pensions was referred to a committee composed of Dr. Henry S. Pritchett, president of the foundation; Dr. W. F. Slocum, president of Colorado College, chairman of the board; Sir William Peterson, president of McGill University; President Charles R. Van Hise, of the University of Wisconsin; President A. Lawrence Lowell, of Harvard University, and Chancellor T. B. McCormick, of the University of Pittsburgh, representing the foundation, and five representatives from the American Association of University Professors, the Association of American Universities, the National Association of State Universities and the Association of American Colleges.

The chemistry building at the State College of Agriculture and Mechanic Arts of the University of Montana, Bozeman, was completely destroyed by fire on October 20. This building furnished quarters for the college and experiment station departments of chemistry, the state food and water laboratory and the departments of physics and geology. The fire occurred in the day time and all department's records, the chemical library and the materials in the chemical and geological museums were

saved together with part of the apparatus. Chancellor Elliott has announced that a new chemistry building will be erected as soon as possible.

FINAL plans have been drawn for a head house for the school of applied science of the Carnegie Institute of Technology, which is to cost $300,000. A portion of the building will be four stories high and the remainder ten. Construction work will start as soon as steel deliveries can be made. The structure will house the executive offices and library of the engineering school, and the departments of modern languages, machine design and commercial engineering.

DR. H. E. EGGERS has been appointed professor of pathology and bacteriology, Dr. Amos W. Peters, assistant professor of biochemistry, and Dr. John T. Myers, instructor in bacteriology, in the college of medicine of the University of Nebraska, Omaha.

PROFESSOR J. VERSLUYS, who has held the chair of zoology and comparative anatomy at Giessen since 1907, has been appointed to the corresponding chair in the new Flemish University at Genth.

THE *Journal* of the American Medical Association indicates that negotiations are pending that may bring Professor R. Bárany, of Vienna, to the University of Stockholm as professor of otology and rhinolaryngology. He recently delivered at Stockholm the customary address describing his research when presented with the Nobel prize. It will be remembered that he was a war prisoner in Russia when notified that the prize in medicine had been conferred on him.

DISCUSSION AND CORRESPONDENCE

CAN A BODY EXERT A FORCE UPON ITSELF?

IN connection with our annual attempt to give our students a few clear ideas about elementary dynamics, the question of the meaning to be assigned to the word *force* perennially arises. May I call attention to a well-known phenemenon which seems well suited to serve as a shibboleth in distinguishing between clear and hazy conceptions of force?

Let a liquid be uniformly rotated in an open vessel. What are the forces acting on each surface particle? Why is the free surface parabolic?

In answering these questions one recent author finds it necessary unwittingly to deny all three of the laws of motion. He states that "When a liquid is at rest or in equilibrium *the resultant of all the forces acting on a particle in its free surface is perpendicular to the surface at that point*" [whereas according to the first law the resultant force must be zero]. In the case of a rotating liquid, we are told, "the resultant force acting on the surface particles is due not only to gravity, but to centrifugal force. . . . It will be noted that the resultant force [shown drawn perpendicular to the free surface] is greater at points higher up on the surface, so that a surface particle near the top presses against the surrounding liquid with far more force than it would if at the bottom of the curve." But according to the second law the resultant force must be in the direction of the resultant acceleration, which in this case is obviously centripetal; and according to the third law, if the particle presses against the surrounding liquid, the liquid must press back upon it with an equal and opposite force not mentioned by the author.

Such an explanation is evidently completely misleading. Yet another recent text-book does equal violence to the laws of motion in explaining the same phenomenon. "The resultant force," we are told, "is made up of two components; one of these is the weight of the particle, mg, the other is the reaction which the particle offers against acceleration toward the center by the centripetal force $mr\omega^2$."

Of course the trouble is that among mathematical physicists it has been customary to reduce such problems to purely statical ones by introducing centrifugal forces in accordance with D'Alembert's principle; but authors of elementary texts sometimes forget that the forces so introduced are purely imaginary.

Does not the third law mean this: A body A can not exert a force upon itself as a whole; any force acting on it must be due to, that is, associated with, the existence of, some

other body or medium B; and that other body or medium B while exerting a force on A, is experiencing an equal and opposite force due to A; whenever the existence of a force on A is discovered we should immediately seek out the body or medium B which is the other party to the transaction; whenever a force is mentioned, the body or medium exerting the force should be clearly in mind.

Considered from this point of view, the answers to the above questions regarding a rotating liquid would run somewhat as follows: The forces acting on a water particle in the free surface are (1) its weight, *due to* the earth, (2) a force *due to* the liquid in contact with it, and (3) a force normal to the surface, *due to* the atmosphere. The resultant of these is a centripetal force since the acceleration is centripetal. If we can prove that the second force is normal to the free surface, then it follows immediately from the force triangle that the normal to the surface makes an angle with the axis of spin whose tangent is equal to the ratio of $r\omega^2$ to g, and that the section of the free surface is parabolic.

The proof we need is the following: Suppose a closed, cylindrical can, full of liquid and with its bottom horizontal, is uniformly rotating around the vertical axis of symmetry. On any co-axial cylindrical surface within the liquid with a radius r there is a pressure because of the rotation equal to $\frac{1}{2}\rho r^2\omega^2$ per cm.^{2}; at any height y above the bottom there is also a hydrostatic pressure due to gravity equal to $P - \rho g y$. The equation for a surface of constant pressure within the liquid is therefore

$$\tfrac{1}{2}\rho r^2\omega^2 + P - \rho g y = \text{constant},$$

$$r^2\omega^2 - 2gy = \text{constant}.$$

But the force on any particle due to the surrounding liquid is, of course, normal to the surface of constant pressure at that point. If we now suppose the can opened on top and all the liquid within a surface of constant pressure removed, the pressure formerly exerted by the removed liquid would be supplied by the atmosphere and the remaining liquid would continue to rotate exactly as before. Thus the free surface of our rotating liquid must coincide with a surface of constant pressure, and the force on a surface particle due to the liquid in contact with it (including surface tension), being normal to the surface of constant pressure, is normal to the free surface. In a similar manner the more general proposition may be proved that the free surface of any liquid whose particles remain at a constant distance from each other during any motion, is *normal to the force with which the liquid acts on the surface particles at each point,* and is not, as often stated, normal to the resultant force acting on them.

When a student finds in an elementary text the statement that "when a body *is* accelerated we may consider the force of reaction as one of the forces acting upon the body," and is told that one of the forces acting on one of the masses of an Atwood's machine, m_1, is "the reaction of the mass m_1 against its upward acceleration" [which is equivalent to the statement that a body when accelerated acts upon itself with a force ma, so that the resultant force is always zero]—when a student tries to reconcile such assertions with the laws of motion, is it surprising that he becomes confused and discouraged?

Why not use force only in the single definite sense implied in the laws of motion?

The fact that the two authors quoted are unusually experienced and successful teachers suggests that they are not the only ones who are making the path of freshmen unnecessarily difficult. I have taken the liberty of using them as "horrible examples" in this respect because their text-books are for the most part admirably clear, and because I know them to be men who are big enough not to resent well-meant criticism.

If there is any question as to the wisdom of the conclusion suggested above, let us thrash the matter out now. To avoid misunderstanding, let me add that in using the phrase "force due to—" for the sake of brevity, no relation of cause and effect is implied in any critical philosophical sense.

Gordon S. Fulcher
University of Wisconsin,
November 3, 1916

LATERAL VISION AND ORIENTATION

TO THE EDITOR OF SCIENCE: Professor C. C. Trowbridge furnished an illuminating paper, printed in SCIENCE September 29, on "The Importance of Lateral Vision in its Relation to Orientation."

In dealing with the question of the process used by man, with his binocular frontal vision, in estimating distances to objects that come within his observation, Professor Trowbridge says:

> It is a well-established principle that binocular vision gives to human beings a means of determining the relative distances between near-by objects, as well as the distances of these objects from the observer. The basis of this power lies in seeing the objects from two points of view, giving a stereoscopic effect, which, however, is decreasingly effective as the objects are removed from the eyes. It is apparently partly the decreasing stereoscopic effect with increasing distance which forms the basis of measurement, and partly a judgment of distance in some way through the muscular movements of the eyes, and those governing the accommodation of the lenses. . . .

From the above quotation it appears to the writer that Professor Trowbridge has missed the fundamental principle of estimating distances to observed objects by human binocular vision. If the writer's view or theory is correct, when a man estimates such distances by his vision, he unconsciously performs a trigonometrical operation, in which the distance between the pupils of the eyes is the base of a triangle, the two lines of vision from the pupils, converging in the observed object, being the other sides of the triangle.

The same principle is used by the "range-finder" on a ship of war, who has a rod about ten feet long as the base of his triangle, from each end of which is measured the angular inclination of the two lines converging in the target, five or ten miles distant. The "binocular" observer has a base two and a half or three inches long, for objects a few hundred feet distant and less. The range-finder makes accurate calculations based on measurements; while the "binocular" observer, from long practise, acquires a sort of "rule of thumb" facility in making such estimates with more or less approximate accuracy, which operation from long habit is performed intuitively and without conscious mental effort.

A man with only one eye, or with defective vision in one of his eyes, finds a difficulty in estimating the correct distance to an object which he extends his hand to grasp; or when inserting a key in a keyhole he must sometimes aid his vision by the touch of a finger to locate the keyhole.

It follows of course that a man with only one eye is without the power to invoke the principle of trigonometry in the estimating of distances to observed objects.

If the above theory is unsound the writer will be glad to have further enlightenment on the question discussed.

T. G. DABNEY

A COMMON, BUT INCORRECT, STATEMENT CONCERNING THE NUMBER OF BACTERIA IN MILK

THE literature discussing sanitary milk problems is full of statements like this: "Certified milk is not allowed to have more than 10,000 *bacteria per c.c.*"; or "Grade A milk should not have over 60,000 *bacteria per c.c.*"; and many other similar statements specifying the *number of bacteria per c.c.* in milk of various grades. These counts are commonly made by the standard agar plate method recommended by the American Public Health Association.

A perusal of a number of bacteriological text-books by American authors shows a general recognition of the fact that these counts are probably counts of groups of bacteria rather than of individual bacteria and that they are probably always lower than they should be because of the fact that not all bacteria will grow on nutrient agar at the incubation temperature used. In spite of these qualifications specifically stated in the majority of these text-books, their authors ignore them in all subsequent discussions and accept agar plate counts as showing the *number of bacteria per c.c.* Occasionally in these books or elsewhere in bacteriological literature, one even finds the bald assertion that each colony

on an agar plate develops from a single bacterium.

The development of microscopical methods of counting bacteria in milk have now made it possible to check up this matter. Studies at the N. Y. Agricultural Experiment Station by J. D. Brew, as well as cooperative analyses carried out by the dairy husbandry department of the N. Y. State College of Agriculture at Ithaca and the bacteriological department of the Agricultural Experiment Station at Geneva have shown that the number of bacteria in market milk is rarely less than twice the number of colonies developing on agar plates even after prolonged incubation at two different temperatures; and that the number of bacteria is usually from three to six times the number of colonies. In those fairly common market milk samples where the predominant bacterial flora consist of long chain streptococci, the actual number of bacteria present may be fifteen to twenty-five times the number of colonies on agar plates.

With these facts established, there seems to be no justification for continuing the present unscientific custom of referring to agar-plate counts as showing the number of bacteria in milk. As a matter of fact they show the number of colonies developing on nutrient agar (or other culture medium) under the conditions of incubation used, and nothing more. In the earlier literature the latter form of expression was common and is still used by some investigators. Americans, however, generally use the inaccurate form of expression especially when discussing sanitary milk problems.

It does not require a vivid imagination to picture the dismay of the layman, whether consumer, milk dealer or farmer, when he discovers that what he has been told about the number of bacteria in milk is all based on a fallacy and that the real numbers are from one and a half to twenty-five or more times the figures which have been given to him. Neither does it require a vivid imagination to predict that those forces which find it to their advantage to resist the efforts which are being made to control our milk supplies will be quick to seize upon the seeming inconsistencies of bacteriologists as a means of discrediting the use of bacterial counts for controlling milk supplies.

So long as there was no available method by which the actual number of bacteria in milk could be counted, the use of the short form of expression had some excuse because of its convenience. Now that the real facts are known, its continued use will increase the present confusion. This confusion does not trouble bacteriologists, nor will it do so, for the majority of them have understood all of the time that they were probably not telling the truth about the matter; but it does bewilder the uninitiated.

Robert S. Breed
N. Y. Agricultural Experiment Station

OSTWALD'S HANDBOOK OF COLLOIDAL CHEMISTRY

In a criticism[1] of my review[2] of Professor Fisher's translation of Wo. Ostwald's "Handbook of Colloidal Chemistry" Professor Richard C. Tolman disagrees with my statements concerning negative surface tension, and submits certain thermodynamic considerations and experiments as evidence of the existence of negative surface tension. The question is one over which two people may disagree inasmuch as it depends solely on their point of view. Professor Tolman relies principally upon thermodynamic considerations, while I refuse to consider energetics as infallible in the present case, but base my reasoning on ordinary atomistics. In fact I regard the application of thermodynamics to disperse systems as decidedly hazardous.

In the first place it is well known (Maxwell) (Smoluchowski) that the second law is no longer valid when applied to particles approaching molecular dimensions. Secondly the first characteristic of all colloidal solutions is *unstability*. I have yet to experience an absolutely stable permanent colloidal solution. Once we admit the absence of true thermo-

1 Science, 44, 565, 1916.
2 Science, 43, 747, 1916.

dynamic equilibrium Professor Tolman's reasoning loses its validity. What is our criterion of stability? Colloidal gold solutions prepared by the reduction of dilute gold chloride solutions with phosphorus are looked upon as being exceedingly stable, in fact they appear almost optically homogeneous under the ultra microscope; yet those prepared by Faraday by this method are still preserved at the Royal Institution—long since coagulated. And of course the rate of change (viscosity) of the hydrophyllic sols mentioned by Professor Tolman is measured in hours and minutes, *i. e.*, they are to be regarded as anything but stabile in the thermodynamic sense. Are we not to consider this question of time at all? Are we to abandon our hope of a kinetic explanation of the change of size of particles when under the ultra microscope we can observe the clumping together of particles and the cessation of the Brownian movement?

As experimental evidence of negative surface tension Professor Tolman cites the gel-sol change of a number of reversible colloids. Perhaps there is an increase of surface in such changes, but our knowledge of the internal surface of gels of gelatine, agar-agar, ferric hydroxide, etc., is, at best, somewhat limited. It can, however, be experimentally shown, from vapor pressure studies of these same gels, that the internal surface is enormous.[3] Furthermore if the internal surface of the gel is decreased (dehydration) the gel-sol change in many cases does not take place. It is therefore an open question as to just what increase of surface occurs in the gel-sol change.

But Professor Tolman should not limit himself to the gel-sol change as experimental evidence of negative surface tension; as a matter of fact he is forced to extend it to include the solution of all substances. For in the process of solution we surely have an enormous increase of surface, consequently an exhibition of negative surface tension. This leads at once to a general theory of solution. Here we meet an old idea that one frequently comes across in scientific literature, but which has never been seriously considered because it represented no real progress.

The fundamental concept of surface tension is molecular attraction, and until we can experimentally show repulsion between molecules *without the addition of external energy,* we must regard negative surface tension as a mathematical quantity to which not much meaning may be attached. In other words, until we can obtain a substance which spontaneously increases its surface (wrinkles and folds), and we must here clearly separate phenomena of solution, vaporization and osmose, we have not much right to speak of negative surface tension.

Professor Tolman quotes Professor F. G. Donnan as a possible exponent of negative surface tension. I can say from a year's association with Professor Donnan that he has long since recognized the futility of ordinary energetics in giving a solution to the perplexing and intricate problems of disperse systems. Is it not better, in view of the multitude of factors involved, to push our experimental study of these systems a bit further, before we burden ourselves with an intricate systematic of doubtful validity? The lines of attack laid out by Freundlich, Zsigmondy, Svedberg and van Weimarn are infinitely more hopeful.

W. A. PATRICK

SYRACUSE UNIVERSITY

[3] I have calculated that the internal surface of one gram of silic acid gel is approximately 2,000,000 cm².

THE RELATION OF OSMOTIC PRESSURE AND IMBIBITION IN LIVING CELLS

IN No. 1115 of this journal Jacques Loeb[1] publishes some ideas regarding the above, which he himself considers "so self-evident that their publication would seem superfluous were it not for the fact that Wolfgang Ostwald and other colloid chemists deny the existence of semi-permeable membranes in the muscle on account of the fact that acid causes proteins to undergo imbibition." Since this article by Jacques Loeb is, therefore, published chiefly for my benefit, I beg to point out the following:

Never, and in none of my publications, have I said anything of this kind. I have never

[1] Jacques Loeb, SCIENCE, 43, 688 (1916).

denied the "*existence*" of semi-permeable membranes in muscle nor have I ever discussed them in any publication. Neither have I denied the existence of such membranes, *because* proteins swell more in acids than in water. In fact, I see no cogent reason for even thinking of these two things as at all related to each other, wherefore the conclusion attributed to me by J. Loeb becomes entirely unintelligible, and appears, as a matter of fact, absolutely absurd. It is true that I have, at various times, lectured on the "*rôle*" of semi-permeable membrane in muscle, and, with many other physiologists and colloid-chemists, have come to the conclusion that these membranes play a much smaller part in the problem of water absorption than many physiologists formerly thought and J. Loeb still thinks. I still regard the rôle of osmotic processes in the problem of water absorption by muscle as only of secondary importance, yet even in my latest publication[2] I state that "I do not wish to uphold the somewhat extreme view that osmotic changes play no rôle whatsoever in the problem of water absorption by organisms." I know full well, moreover, that this position is regarded as too conservative by some of my colloid-chemical colleagues and as inadequate in the light of the newer developments of our knowledge.

These facts make it evident that J. Loeb is absolutely wrong in his statement that I have denied the existence of semi-permeable membranes in muscle, and still more wrong when he says that I have done this "on account of the fact that acid causes proteins to undergo imbibition." So far as *my* published thoughts regarding this question go, the statements in the article of J. Loeb appear, as a matter of fact, not only, as he says, "superfluous," but wrong and misleading. The whole argument of J. Loeb is based upon an entirely arbitrary distortion of my views.

Wolfgang Ostwald

University of Leipzig,
August 5, 1916

[2] Wolfgang Ostwald, "Die Welt der vernachlässigten Dimensionen," 133. Dresden and Leipzig, 1915.

SCIENTIFIC BOOKS

Weather Forecasting in the United States. By a Board consisting of Alfred J. Henry, Edward H. Bowie, Henry J. Cox, Harry C. Frankenfield. Washington, 1916, Weather Bureau, No. 583. C. F. Marvin, Chief. Pp. 370, 119 charts.

This volume of meteorological studies is timely in its appearance and creditable as to its contents. Time and again the question has been raised as to whether weather forecasting is entirely empirical or based on scientific principles within ordinary comprehension. Almost synonymously with these memoirs appeared the bulletins of the Carother's Observatory, Houston, Texas, on the correlation of solar and weather phenomena, with which system of long-time weather predictions Professor Willis Moore, former chief of the Weather Bureau, is associated. This observatory announces the issue, for each state, of long-time forecasts ranging from eleven to eighteen days in advance. These forecasts are based on variations in the solar radiation received by the earth, which are said to cause rotating cyclonic eddies in recurring periods of eighteen days. The Carother's method of forecasting is only one of several systems advanced by individual scientists in the United States, which seek public recognition as to the value of their theories and as to the accuracy of their weather predictions.

At times the U. S. Weather Bureau has issued forecasts for even a week in advance. It has remained for the Argentina service, beginning in 1915 under Professor Wiggins, to regularly issue forecasts for a week, indicating the temperatures for 8 A.M. and 8 P.M., as also the days on which rain is expected.

Since Professor Marvin, the chief of the Weather Bureau, has officially stated that systems of the Carothers and allied types are fallacious, it is of special importance that the general public should be definitely informed as to groundwork of the national weather forecasting. This system has been developed during the past forty-six years under the control and direction of Generals A. J. Myer, W. B.

Hazen, A. W. Greely, followed by Professors H. W. Harrington, Willis Moore and Charles F. Marvin. The theoretical evolution has been principally accomplished by a civilian staff, among whom may be mentioned Ferrel, Abbe, Maury and Humphreys, and the practical work by officers of the army, by observers and professors. The present force has risen from the lower grades through successful work of a quarter of a century or more to commanding positions.

This review does not discuss the relative merits of the various systems, official and non-official, but seeks to summarize with brief comments the accuracy or fulness of the official national methods herein presented, concerning which the public is not generally informed.

The reviewer prefaces his comments by stating that notwithstanding his open mind to scientific discoveries in meteorology, yet his views on long-time forecasts were formulated and published more than a quarter of a century since, in *American Weather,* N. Y., 1888. In this publication, the first American work wherein definite rules for forecasting were advanced, after quoting Blanford as to droughts and temperatures, the present writer found the sun-spot theory fallacious as to rainfall in the United States, but added:

> The advances of meteorology are insufficient to justify predictions of the weather for a season in advance. There are apparently good grounds for believing that general laws can be deduced by which, from abnormal distributions of atmospheric pressure, to predict for prolonged periods in advance the general character of the coming season, as warm or cold, and wet or dry.

Almost without exception the authors of the various memoirs in weather forecasting have had practical experience in meteorological work with the Weather Bureau for thirty years, and so speak with a degree of authority that makes their opinions worthy of careful consideration.

The first essay, modestly styled Introductory Note, by Professor C. F. Marvin, sets forth clearly and succinctly the theory of atmospheric circulation, the essential basis of the science of forecasting. His action in promptly initiating these investigations, in 1913, gives promise of further memoirs as later studies add to meteorological knowledge.

Professor W. J. Humphreys has brought together a comprehensive summary of existing knowledge as to winds, cyclones and anti-cyclones. He advances reasons as to why the average velocity of winds steadily increases to 600 meters' elevation, decreases to 1,000 meters, and after fluctuations steadily increases from 2,000 meters upward. In this connection he believes that:

> The horizontal pressure gradient maintained by the temperature difference between adjacent regions is approximately constant with a tendency towards a maximum gradient at about 8 kilometers roughly.

In connection with the origin of cyclones and anti-cyclones Humphreys considers the various hypotheses: Ferrel's convectional, Hann's driven-eddy—both discussed by Professor Davis—and Mitham's counter-current. He believes that none of these theories contains clear and workable conceptions of "the origin, mechanism or maintenance of the extra-tropical cyclones," but that they "still remain the meteorological mysteries they have always been." He points out that tornadoes, "well-nigh peculiar to the United States east of the Rocky Mountains," develop usually in the southeast quadrant of a low-pressure area, the tornado being "a vigorous convection between strong neighboring counter-currents." He indicates the presence of permanent and semi-permanent low areas.

It is to be regretted that he did not consider in this connection the normal transfer to and from various regions, in the northern hemisphere of pressures from month to month, which, deduced largely from the international series of simultaneous observations, were charted and briefly described by the writer twenty-six years ago.

Coming to the practical problems, Professor A. H. Henry treats the subject under the head of weather forecasting, pressure changes, highs and lows, and forecasts in the Washing-

ton district. He outlines clearly the synoptic chart method, the basis of all American weather forecasts. The general control of the weather through atmospheric changes of pressure are shown, with their general course from west to east. Illustrating typical lows by charts, he indicates seven separate types: circular, secondary, V-depressions, cols or saddles, anti-cyclone, wedge-shaped and straight isobars. The result of such typical formations are discussed quite fully.

Speaking of the maps of temperature and pressure changes, the two most valuable charts in forecasting, an error is committed in speaking of them as made thrice daily. The writer reduced the observations from tri-daily to semi-daily about thirty years since—a great reduction in expense, much criticized at the time, but which did not reduce the efficiency of the service.

While the associations of high temperatures with low pressures, and of low temperatures with high pressures are noted, yet Henry frankly admits that allobars—the technical term for areas of pressure changes—remain a mystery. Forecasts from katallobars, areas of falling pressure, are considered under the headings: changes in form, greatest fall at center in twelve hours, and concentration of fall. While allobars are perfected in twelve hours in Canada, the time increases southward to thirty-six hours in the Gulf States. The memoir on highs and lows is quite complete. Henry points out that "the movement of lows seems to coincide with the seasonal direction of the planetary winds, of which they are doubtless a part," and states that the "speed of lows varies directly with the strength of the general winds." As to precipitation, in addition to other comments, he considers that "when the high is north or northeast of the low, the tendency to unsettled weather and precipitation in the regions between them is at a maximum." The lows are considered by groups, according to their primary appearance, as follows: North Pacific, South Pacific, Alberta, Northern Rocky Mountain, and Colorado, Texas, East Gulf, South Atlantic. Highs are similarly treated.

Forecasting in the Washington district, by Henry, contains treatment of seasonal influences. He gives for Ohio five rules for warmer weather, and six for colder weather. It would have been most valuable if he had added similar rules for other states. As to the prolonged heated terms in the middle Western States Henry says:

> They are probably due to fundamental causes in the general circulation, the nature of which we do not know.

They end with the disintegration of a southeastern high and the formation of a northwestern high.

Cold-wave forecasts are fully treated by Professor H. J. Cox, who finds the pressure-change charts far the most important element therefor. Cold waves usually occur through the rapid advance, with steep barometric gradients, of highs in rear of well-marked lows. Cox describes the various types of cold-waves, and sets forth the effect thereon by topography, especially by the Great Lakes and by the proximity of the ocean. Well-selected charts illustrate the formation and advance of such waves. He points out that atmospheric conditions for vast distances, even over an area of 4,000 sq. miles, are potent factors, through temperature, pressure, humidity, pressure gradients, cloudiness and snow-covered areas.

Supplementary to cold waves Cox discusses frost warnings, indicating the modifying influences of topography, especially in the shape of large bodies of water, moist soils and drained land. He also dwells on the different effects of fast and of low moving highs, the latter often producing frosts for successive nights. Dew-point readings in the evening are considered fallacious indications as to frosts, while humidity percentages have influences not clearly understood as yet.

Local peculiarities as to cold waves and frost-warnings, of much value and interest, are presented by Forecasters John W. Smith, of New England, L. M. Cline for the West Gulf, F. H. Brandenburg for Denver, E. A. Bealls for the North Pacific and G. H. Willson for the South Pacific. These experienced fore-

casters also present valuable data and opinions as to weather and temperature forecasts in their respective districts.

The subject of high winds is efficiently treated by Forecaster E. H. Bowie, who indicates the various types of pressure from which they occur. While pressure gradients induce high winds of definite relative force, yet exceptions to the rule are noted. Hurricanes, northers and blizzards receive due consideration. He mentions the intensity of action caused by twelve different types of lows. Special supplementary treatment of the storm winds of the Atlantic and Gulf coasts is presented by Professor H. C. Frankenfield, and similar data for the North Pacific coast by Forecaster Bealls, for the South Pacific coast by Forecaster Willson, and for the Great Lakes by Professor Cox.

Professor H. C. Frankenfield discusses the forecasting of snow, of sleet and ice storms, dwelling especially on their seasonal and geographic distribution. He indicates seven distinct conditions precedent to sleet and ice storms, and five necessary conditions preceding fog formation. Similar treatment of thunderstorms comes from Professor Henry.

Forecaster Bowie in discussing long-range weather forecasts considers seasonal forecasts as improbable even in the near future. He indicates, however, sixteen types of pressure conditions in various regions of the northern hemisphere which enable meteorologists to forecast conditions, elsewhere consequent, from two days to two weeks in advance.

The bibliography and index are unsatisfactory, and most annoying to any student. There are about a score of publications referred to in the text which do not appear in the bibliography, while titles of small import are given place. This is a small matter, but it mars the publication.

As a whole, while these memoirs will be indispensable to every forecaster and experienced meteorologist, as far as the public is concerned they will be valuable only to advanced students of the science. They are quite beyond the scope indicated by Chief Marvin as a text-book or manual suitable for the guidance and instruction of beginners. It is to be hoped that in due time there will appear a series of local manuals—not more than 24 pages in length—wherein should be presented such simple rules as would enable business men to still further utilize the daily weather map. The writer had a similar intent when he incorporated in *American Weather* twelve rules for general use in weather forecasting, which the board of professors has generously recognized in their preface. Doubtless a hundred similar rules—simpler and better—could be deduced by the experienced professors who have prepared these memoirs, whose value to students is recognized as of the highest order.

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SPECIAL ARTICLES

THE RESULTS OF EXTIRPATION OF THE ANTERIOR LOBE OF THE HYPOPHYSIS AND OF THE THYROID OF RANA PIPIENS LARVÆ

THE writer has long been impressed with the desirability of testing the effects of extirpation of the glands of internal secretion at the very beginning of their development in order to determine the part that they play in the development and differentiation of the embryo. Of all the vertebrates the anurans seemed to offer the greatest opportunities for such work. Adler ('14)[1] performed experiments of this kind, but the operation was carried out at a late stage and consequently did not entirely exclude the early influence of the gland. Early in the spring of 1915 the writer removed the anlage of the anterior lobe of the hypophysis at the time of closure of the medullary folds by removing the surface ectoderm from which it would shortly afterwards develop. This attempt resulted in a large degree of mortality and was abandoned. This spring the operation was successfully accomplished by making a transverse frontal cut extending back the entire length of the fore brain and parallel to it a sufficient distance below to just expose the ventral surface of the hy-

[1] Adler, L., "Metamorphosestudien an Betrachierlarven. I. Extirpation endokriner Drüsen. A. Extirpation der Hypophyse." *Arch. f. Entwickelungsmech. d. Organ.*, Bd. 39, 1914.

pophysis ingrowth. When this is performed at the stage of from 3.5–4 mm. total body length the hypophysis anlage can be readily seen and removed. The wound heals in from 20 to 30 minutes and the tadpoles quickly recover. In the course of these experiments the anlage was successfully removed from 430 tadpoles.

This phase of my work was duplicated by Dr. P. E. Smith,[2] who published a preliminary account of his work in the August 25, 1916, number of Science. During the month of July prior to this time I had the pleasure of discussing my work with Dr. Smith at Berkeley. Previous to this time I had no knowledge of his work nor of his plans and he assures me that he was equally ignorant of my work. We both presented papers upon our experiments at the meeting of the Western Society of Naturalists at San Diego, August 9 to 12. On the 7th of June, before starting west, I demonstrated specimens and explained my results to a number of scientists, including Professor Frank R. Lillie, Dr. Emil Goetsch, Dr. Chas. H. Swift and a number of others whom I met in Chicago at that time. It is thus clear that these experiments were independently conceived by Dr. Smith and myself and that we worked contemporaneously upon them each without knowledge of the other's work until July, 1916, two months after the experiments had been performed. It was impossible to give an earlier report upon this work because the experiments upon thyroid removal required a long period of time to establish definite results.

Our results are in accord in showing that the removal of this gland has an early effect in producing a great contraction of the superficial pigment cells. The results in my specimens were very striking. I found that my tadpoles assumed a uniform creamy silver color. This change was evident on the seventh to eighth day after the operation. Our work is further in accord in that we both observed a retardation in growth very marked in my material and a striking retardation in the development of limbs. The buds appeared but remained very small. One specimen kept alive until August 30 had only reached a length of 30 mm. and the limb buds were still extremely small after the controls had all fully metamorphosed into frogs. Through all this time it maintained its silvery color.

Dr. Smith found that there was no more mortality among his operated tadpoles than among the controls. This is quite contrary to my experience; but is no doubt explainable upon the grounds that he had a more favorable water supply than ours. In my experiments upon removal of the hypophysis there was a very heavy mortality. I am convinced that this must be explained upon the ground that the presence of the hypophysis anlage is necessary for the proper adjustment of the tadpoles to these injurious influences. It might be mentioned at the outset that in roughly one third of the operated tadpoles the upper part of the mouth was defective. This was due to the removal or disturbance of its anlage in the operation. These tadpoles were of course doomed to die, but this can not account for the fact that in one experiment in which 30 were operated only 4 remained alive at the end of 33 days.

In another experiment the case was made still more clear. Of 100 operated tadpoles only 7 remained alive at the end of 32 days—of these there had been failure to remove the hypophysis in one case and in another there had probably been partial failure. A control set was reared in which the cut was made as though for removal of the hypophysis, but the gland was left intact. Of the 28 thus treated 14 were alive at the end of 42 days. At this time they were in a very flourishing condition, although the operation caused a temporary retardation of growth.

In other sets of experiments there were usually one or two tadpoles that failed to show the characteristic color change. These were invariably hardy. Upon sectioning them the hypophysis was found intact.

Operated tadpoles and control lots were kept side by side in the same or neighboring aquaria and the operated ones invariably showed heavy mortality while the control tadpoles were healthy. This mortality did not appear until

[2] Smith, P. E., "Experimental Ablation of the Hypophysis in the Frog Embryo," Science, August 25, 1916, p. 280.

at least a week after the operation, long after complete recovery, and it was not evident in certain cultures so long as they were kept in well water, appearing only after they were placed in our city water.

The interesting thing is that other tadpoles that had undergone a more severe operation in the removal of the thyroid gland showed no appreciable mortality until after the lapse of a month, when they had grown so large as to crowd the aquaria. These were kept in conditions identical with those under which the tadpoles deprived of the hypophysis showed such heavy mortality.

I propose next spring to determine if possible whether this lack of resistance is of a general character or whether the absence of the hypophysis causes a heightened susceptibility to specific injurious substances or conditions.

These experiments upon removal of the hypophysis represent only one phase of my work; similar methods were applied to the extirpation of the thyroid anlage. This was removed at a slightly later stage 6–6.5 mm. total length shortly after it appeared. In this case a transverse cut was made between the heart and the thyroid anlage and the latter was readily removed. In some instances a small portion of it may have been left behind, but in the main the operation proved successful as demonstrated in sections of operated tadpoles. Recovery from the operation was quite as rapid and complete as in the case of hypophysis extirpation. This operation was successfully performed upon 336 tadpoles.

As indicated above, for a long time after the operation the tadpoles showed no ill effects from the absence of the thyroid gland as regards either size or vitality. In fact they appeared in every way normal up to the time when the hind limbs began to form. When they began to die as a result of overcrowding and other unfavorable conditions that became marked at about 6 weeks after the operation, there was an even greater mortality among the controls.

The metamorphosis of the controls began about the middle of July and continued to August 13, when the last control tadpole metamorphosed. Five of the operated tadpoles metamorphosed at about the same time as the controls. One metamorphosed much later—September 20.

At the present date, October 1, twelve operated tadpoles ranging in length from 85 mm. to 123 mm. are living and show no tendencies toward metamorphosis. The hind-limb rudiments are rather uniformly about 4 mm. in length. The knee is evident and the toe points distinguishable. The larval characters as a whole are maintained. The intestine, the mouth, eyes, etc., are all larval in character, although a peculiar modification in the form of the head is noted in that the portion in front of the eyes is lengthened, broadened and flattened dorsoventrally. It is thus clear that the removal of the thyroid gland has caused these tadpoles to remain in a larval condition for a month and a half after the controls have completed metamorphosis. Section of 7 operated tadpoles at various stages from 9 to 24 mm. showed no vestiges of the thyroid gland. A careful study of the operated animals that have undergone metamorphosis is being carried on to determine whether small portions of the gland have remained after the operation or whether there may not have been new formation of thyroid tissue. Upon sectioning one of these a single well-developed thyroid gland was found on one side. This clearly shows that we were here dealing with a case of imperfect removal.

The results of this experiment establish a corollary to the experiments by which Gudernatsch and others have shown that thyroid feeding—hyperthyroidism—greatly accelerates metamorphosis. Conversely, in the absence of the thyroid gland metamorphosis is at least greatly retarded. How long this may continue remains to be seen.

A careful study of the material is being made to observe the effects of the removal of these glands of internal secretion upon the body as a whole and upon the various organs. The results should be especially interesting because we are dealing with material in which the earliest anlagen of these glands have been removed.

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P. S. As this goes to press, November 17, nine of the thyroidless tadpoles are still alive and have increased in size. One has been fed thyroid preparations for 25 days but in very small amounts and at long intervals for fear of fatal results. The hind legs have reached a length of 9.5 mm. and the fore legs are evident beneath the skin. The tail has become greatly shortened and the head is assuming the character of a frog's head. The legs of all the other tadpoles have remained stationary in development at a length of 4 mm. and the tadpoles as a whole show no further signs of metamorphosis. Another tadpole of 29 mm. heavily fed with thyroid, died after 4 days. When compared with a thyroidless tadpole of practically equal body length it was found the intestine of the thyroid fed tadpole had been reduced to a length of 143 mm. as compared with 237 mm., the length of the intestine of the thyroidless tadpole that had not been fed thyroid.

B. M. A.

MICROTECHNICAL METHODS FOR STUDYING CERTAIN PLANT-SUCKING INSECTS IN SITU

A PROBLEM on which the writer has been working for the past year, viz., determining the relation of certain sucking insects to their host plants, has necessitated the development or adaptation of several points of microtechnique which may be of use to other investigators along similar lines. Sectioning insect and plant tissue together has not been attempted often, as the usual methods suitable for one are out of question for the other. It is also necessary to cut quite hard tissues and to employ stains for chitin which also will not dissolve the middle lamellæ separating the plant cell-walls.

The material for study must be fresh. Usually most satisfactory results are obtained if the bottles of killing fluid are taken into the field, the parts of plants bearing the insects cut off with a sharp knife, and immediately immersed. Aphididæ and others of the more active forms must be removed with the part of the plant on which they are feeding and killed before they have time to pull out the proboscis, otherwise their natural positions in feeding can not be studied. For the gelatine method of embedding, which the writer has used quite extensively, pieces of pine needles, each bearing a coccid at one end, are tied in bundles of ten to twenty, making it possible to get sections of many needles at once; with the use of a killing and fixing agent which penetrates rapidly and easily no difficulty from improper fixing of parts of these bundles is experienced.

Of the killing solutions a variety was tried, Jeffry's[1] proving in most cases the most satisfactory, as the picric acid in it stains chitin. Also it softens hard plant tissues so that it is possible to cut paraffin sections of leaves as hard as *Citrus* without further softening. It may be used hot for twenty minutes or cold for several hours. Care must be taken to wash thoroughly in alcohol or iodin alcohol (30 per cent. alcohol which has been turned to a light wine color by the addition of iodin), otherwise crystals of mecuric bichlorid will remain. Carnoy's fluid[2] also proves successful, particularly with active insects having much secretion of wax, *e. g.*, the aphid *Chermes*, which with less quickly penetrating solutions encloses a drop of air, thus enabling the insect to free its beak before death. Its hardening properties are overcome by thorough washing in absolute alcohol, followed by 95 per cent., 85 per cent., 70 per cent., 50 per cent., 30 per cent. strengths, and then softening in Jeffry's solution.

The gelatine method for embedding[3] has been found by the writer very successful for many hard tissues. It deserves extended trial with plant tissues usually considered too hard for sectioning. It is a short method: the material does not require dehydration before its use, therefore hard tissues are not rendered harder than they naturally are. Further, the

[1] Corrosive sublimate, saturated solution in 30 per cent. alcohol, 3 parts. Picric acid, saturated solution in 30 per cent. alcohol, 1 part.

[2] Absolute alcohol 6 parts, chloroform 3 parts, glacial acetic acid 1 part.

[3] Land, W. J. G., "Microtechnical Methods," *Bot. Gaz.*, Vol. 59, May, 1915, p. 400. Chamberlain, C. J., "Methods in Plant Histology," 3d revised edition, p. 128.

natural condition of the structure is maintained, there being but little shrinkage. Cell contents relatively insoluble in water, but soluble in xylol and oils, are not lost. Sections as thin as 10 microns can be cut with ease. However, serial sections can not be cut, nor can some stains be used unless the gelatine is dissolved away after sectioning, which is not easy to do. The method is as follows: Ordinary cooking gelatine is soaked two or three hours, or until it will absorb no more water, then after the excess of water is poured off it is warmed until melted. A temperature of not over 70 degrees Centigrade should be maintained. Part of the liquid gelatine is now thinned with an equal volume of water and the material to be embedded is kept in this dilute gelatine for several hours, during which it must be warm enough to remain liquid. Following this, concentrated gelatine is used similarly for several hours more. The dishes containing the material being embedded should be corked to prevent drying. The material is now cooled in a paper tray coated with paraffin, after which it is hardened for several days in 4 per cent. formalin. The microtome knife must be sharp, with no bevel on the lower side, and set at as great an angle as possible. Either alcohol or water may be used to flood the knife in cutting. Pieces of the gelatine with embedded material are, as a rule, strong enough to be clamped in place in the machine without wooden blocks as supports.

Materials which can not be cut otherwise yield easily to the knife after the use of dilute or concentrated hydrofluoric acid[4] for one to three weeks, which is followed by thorough washing in water, then the regular paraffin method. Ample time for each stage of the paraffin method to permit dehydration and embedding of the large pieces must be given.

Acknowledgment for many suggestions is made to Dr. L. L. Burlingame, of the botany department of Stanford University.

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[4] Bailey, I. W., "Microtechnique for Woody Structures," *Bot. Gaz.*, Vol. 49, January, 1910, p. 58.

THE ECOLOGICAL SOCIETY OF AMERICA

A MEETING of the Ecological Society of America was held in the High School building at San Diego, California, on August 10 and 11, 1916, and two joint sessions were held with the Western Society of Naturalists. About twenty-five members were present, the chair being occupied by the secretary-treasurer. Members of the society participated in the biological dinner at the U. S. Grant Hotel on the evening of August 12. On the afternoon of that day the work of the Scripps Institution was demonstrated by members of its staff. On August 13 and 14 the members of the Ecological Society were guests of the San Diego Society of Natural History on a 200-mile automobile trip to the Cuyamaca Mountains and the edge of the Colorado Desert.

Following are abstracts of papers presented at the sessions of the society:

The First Stage in the Recession of the Salton Sea: D. T. MACDOUGAL.

The Trees and Shrubs of the Grand Canyon of the Colorado: ALICE EASTWOOD.

The zones of plant life in the Grand Canyon may be defined by the trees and shrubs which characterize them. The great diversity of environment results in complexities of distribution which offer a promising field for ecological investigation. Fifty lantern slides were shown, made from herbarium specimens of the leading trees and shrubs of the Canyon, collected on the Bright Angel, Hermit and Berry trails.

Results of the Effect of Chaparral and Forest Cover on Meteorological Conditions: EDWARD N. MUNNS.

Records have been taken daily at three stations at the Converse Experiment Station, for three successive years. One station is located in an open cienega, one in a chaparral field, the third in a forest of jeffrey pine, all stations being about 6,000 feet elevation.

The records show the mean annual temperature under the chaparral cover is 2°.8 higher than in the open, and that of the forest 1°.2 higher. More important are the extremes, the mean maximum in the chaparral, being 5°.7 higher and the mean minimum 2°.0 lower than in the open, while the mean maximum under forest conditions is 1°.4 lower and the mean minimum 3°.8 higher than in the open. The mean daily range in the open is 26°.5, that of the chaparral 7°.7 greater, and that in the forest 5°.2 less.

Soil temperatures are greatest in the open, and least in chaparral with a difference of 1°.0 be-

tween chaparral and forest, and 6°.0 between chaparral and open, the differences being greater in summer and least in winter.

Eighty per cent. of the precipitation reaches the ground under chaparral and seventy-two per cent. under the forest, much more water reaching the ground from snowfall under chaparral than forest. A difference of 5 per cent. exists between open and areas under cover, though there is but slight difference between the types of cover. Evaporation in the forest is 85.2 per cent. that of the open, while the chaparral evaporation is but 47.2 per cent.

Plant Succession in Badlands: Frederic E. Clements.

An account of the revegetation of the highly eroded clays and shales, known as Badlands. The areas considered are the Oligocene-Miocene deposits of the Hat Creek Basin in Nebraska, and of the White River in South Dakota, the Eocene of the Little Missouri in North Dakota and Montana, Miocene volcanic deposits in Wyoming, and the Mancos Shales of Colorado, Wyoming, Utah and New Mexico. In the last, the climax is the *Atriplex-Artemisia* formation of the Great Basin region. In all the others, the climax is the prairie-plains grassland, except in the Black Hills proper, where it is the *Pinus ponderosa* forest. The soil water of the Mancos Shales is saline, and the succession type is the halosere, consisting of halophytes and terminating in a sage-brush climax, or rarely in juniper-piñon woodland. In all the Tertiary Badlands of the Great Plains region, the fine-grained compact soil, the steep slope and the low but torrential rainfall make xerophytic succession, as represented by the xerosere, typical. The hydrosere and halosere are relatively rare, while subseres are especially favored by the nature of the soil. The climax is usually reached in the *Stipa-Agropyrum* prairie association. In drier regions, the climax is the *Bulbilis-Bouteloua* short-grass association, and in wetter ones, the *Pinus ponderosa* consociation.

A Summary of Bog Theories: George B. Rigg.

A discussion of the character and occurrence of sphagnum bogs, and a presentation of the theories that have been advanced to account for the xerophily of bog plants, the possible sources of toxic substances in bog water, and the manner in which these substances influence the activities of plants.

Vital Statistics of the Yellow Pine through an Altitudinal Gradient of Climatic Conditions: Forrest Shreve.

Vital statistics have been secured for *Pinus arizonica* at elevations of 6,000, 7,000, 8,000 and 9,000 feet on south-facing slopes in the Santa Catalina Mountains, Arizona, and on north-facing slopes at 6,000 and 7,000 feet. The number of adult trees (10 cm. and over) per unit area decreases with decrease of altitude, except on the south-facing slopes at 6,000 feet. The total volume per unit area decreases with decrease of altitude, the exceptional stand at 6,000 feet being composed of a relatively large number of small trees. The number of seedlings and smaller trees bears no relation to altitude on the areas examined. Curves were exhibited showing the rate of growth at the four altitudes.

The Influence of Environmental Conditions in the Origin of a Narrowly Localized Race of Mice: Francis B. Sumner.

The Distribution of Pocket Gophers in California: Joseph Grinnell.

On Some Varieties of Thais (Purpura) lapillus and their Relation to the Environment: Harold S. Colton.

On account of its abundance and great variation, *Thais (Purpura) lapillus* forms a very favorable material for a study of some of the conditions of life on the rocky shores of the New England coast. Over twelve thousand shells were collected and sorted from sixty-seven localities in the neighborhood of Mount Desert Island, Maine. *Thais* is found in the rock association and the boulder association of the littoral formation wherever its food, *Balanus*, the barnacle, and *Mytillus*, the mussel, is found. The environments were classified according to the size of the waves on the beach and on the color and character of the rocky substratum. A study of the varieties showed that (1) in the surf and in the sheltered harbor the snails of a given age were smaller and darker than those found in the bays. More were also apt to be lamellated in the surf or harbor than in the bays; (2) light forms are apt to be found on light-colored rocks, but there is no great correlation between yellow snails and yellow rocks or banded snails on banded rocks; (3) there are other factors which act on a whole region irrespective of the wave action or substratum. An example of this was found in comparing the number of lamellated forms in the Somes Sound region with the Blue Hill Bay region adjoining. In the former, whether in harbor, bay, or surf, lamellated forms are rare (6 per cent.). In the latter they are common in the harbors, as much as 96 per cent. in some, absent in the bay but common (17 per cent.) in the surf.

Thais feeds in this region on barnacles and mussels. It is destroyed (1) by cannabalism within the egg capsule; (2) by fish when young; (3) by herring gulls when old; (4) by shore ice in the winter. A comparison of collections made on islands on which the gulls breed, with situations where there are not so many, seems to show that the proportions of color found are determined by selection.

An Inquiry into the Relative Importance of the Various Phases of the Environment in Determining Plant Distribution: WM. E. LAWRENCE.

This paper presents the results of an inquiry into the literature to ascertain what researches throw light on the problems of plant distribution. It includes a discussion of the relative importance of phylogeny, historic geology, climatic cycles, topography, climatic and edaphic factors as they affect the distribution of plants. The inherited physiological and morphological characteristics of a plant, on account of its phylogenetic relation, are considered first because they define the limit of the plant's response in terms of the environment. Geological factors have, of course, greatly influenced the preceding, but they are equally important in determining the components of the endemic flora. Climatic and edaphic factors are effective at present. Of these no one factor or combination of factors is found to be all dominant. Under certain less variable conditions or combination of factors, the more variable factor or factors appear to dominate the physiological activity of the plant and hence determine its success in such an environment. There are, therefore, no limiting factors in plant distribution except as the conditions are defined. Under proper conditions every known factor in nature may limit growth and reproduction, hence distribution. The control of these conditions one by one is exactly the method of experimentation. When we attempt to analyze the natural conditions, we merely interpret according to the laws of experimentation. There seems to be good reason to believe that the distribution of certain plants and plant associations are in some cases limited by one factor such as water and in other cases by other factors such as temperature. The whole situation is likely to be obscured in nature because of the innumerable possibility of combination and the factors of preoccupation and competition. An ecological classification is presented based upon the greatest variable factor for any given area, whether the area is defined on the basis of physiography, plant association, or other limits.

On the Relation between the Rate of Root Growth and Oxygen: W. A. CANNON.

A series of experiments is reported on in which the roots of *Prosopis velutina* and of *Opuntia versicolor* are exposed to atmospheres of (1) pure carbon dioxide, (2) and atmospheric air so diluted with carbon dioxide that a mixture containing 5 to 25 per cent. oxygen results. It was found that the roots of both *Prosopis* and *Opuntia* can maintain a feeble growth rate in an atmosphere containing as little as 5 per cent. oxygen, but that root growth in both species stops in pure CO_2. The recovery from the asphyxiation occurs sooner in *Prosopis* than in *Opuntia*, and in both at higher sooner than at lower soil temperatures. The results indicate that the response of the roots of *Opuntia* to a diminished oxygen supply, such as occurs with increasing depth beneath the surface of the ground, is a contributory factor among those which bring about the superficial placing of its roots.

The Relation between Marine Biology and Ecology: ELLIS L. MICHAEL.

To understand marine organisms is the function of marine biology. To what extent, how, and why are marine organisms adapted to the particular environments in which they live? In short, by virtue of what is a marine organism marine? This is the central question in marine biology: all others are strictly tributary to it. Fully grasped, this means that the significance of no phenomenon essential to the life of any marine organism can be fully understood so long as any other phenomenon likewise essential to it is entirely ignored. Knowledge of the environment is therefore as indispensable to a complete understanding of marine organisms as is that of the organisms themselves. Continuous and intimately coordinated investigations in chemistry, physics and hydrography as well as in morphology, embryology and physiology are indispensable. There is, therefore, a certain natural order of progress in marine biology. Details can not be stipulated, but this much is certain: after the various organisms to be investigated have been identified, it is necessary to determine how they are related to the elements of their environmental complexes before it will be possible to discover how or why these relations are maintained. That is, the initial step must be one in field ecology. Then would follow the more intensive studies of structure, function and behavior—morphology, embryology, physiology and experimental ecology—required to fully

understand the organism as it actually lives in nature. Not until this has been accomplished may it be truly claimed that an investigation in marine biology has been carried to its logical termination. This same conception, of course, applies to land organisms and fresh-water organisms; to mountain biology, desert biology, lake biology, river biology, etc. It is that conception which insists that no organism can be fully understood, in its structure and function quite as much as in its distribution and behavior, apart from its natural abode.

Variations of Picris echioides: R. R. Gates.

Picris echioides is a European plant introduced into California. In a small colony of this composite at Berkeley several marked variations were observed. The most interesting of these were two individuals in which all the florets of the heads were "quilled" or tubular, instead of all being flat and ray-like, as in the ordinary form. In the normal form the heads open early in the morning, but on bright days they are closed again by noon, while in the quilled variation the heads remain open several hours longer and never completely close. Hence there is a marked difference in the physiological reactions of the two forms. Another variation is in the color of the rays, which are usually dark yellow; but occasional plants occur in which all the rays are pale lemon yellow. Again, the stems are usually green, but occasionally reddish throughout. There are also great differences in size, which are very probably genetic in nature. The shortest plants are slender and only 18 inches high; while the tallest are very stout, differ in their branching, have much larger leaves and reach nearly 5 feet in height. Other differences can also be observed, indicating that a considerable number of genetic variations exist in this interbreeding population. It is not known whether similar variations occur in this species in its natural European home.

Forrest Shreve,
Secretary-Treasurer

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and eighty-sixth regular meeting of the American Mathematical Society was held at Columbia University on Saturday, October 28, extending through the usual morning and afternoon sessions. The attendance included thirty-nine members. President E. W. Brown occupied the chair. The council announced the election of the following persons to membership in the society: Mr. A. C. Bose, Calcutta, India; Professor L. C. Emmons, Michigan Agricultural College; Professor A. M. Harding, University of Arkansas; Dr. W. L. Hart, Harvard University; Dr. J. R. Musselman, University of Illinois; Mr. S. Z. Rothschild, Immediate Benefit Life Insurance Company, Baltimore, Md.; Professor Pauline Sperry, Smith College. Six applications for membership were received.

Committees were appointed to audit the treasurer's accounts and to arrange for the annual meeting in December and the summer meeting of 1917.

The following papers were read at the October meeting:

Mrs. J. R. Roe: "Interfunctional expressibility problems of symmetric functions."

E. D. Roe, Jr.: "A geometric representation."

E. D. Roe, Jr.: "Studies of the Kreisteilungsgleichung and related questions."

E. D. Roe, Jr.: "The irreducible factors of $x^n + x^{n-1} + x^{n-2} + \cdots + 1$."

H. B. Mitchell: "On the imaginary roots of a polynomial and the real roots of its derivative."

J. H. Weaver: "Some properties of parabolas generated by straight lines and circles."

F. N. Cole: "Complete census of the triad systems in fifteen letters."

O. E. Glenn: "Translation surfaces associated with line congruences."

O. E. Glenn: "Methods in the invariant theory of special groups, based on finite expansions of forms."

R. L. Moore: "A theorem concerning continuous curves."

J. R. Kline: "The converse of the theorem concerning the division of a plane by an open curve."

H. S. Vandiver: "Note on the distribution of quadratic and higher power residues."

H. S. Vandiver: "The generalized Lagrange indeterminate congruence for a composite ideal modulus."

The annual meeting of the society will be held at Columbia University on Wednesday and Thursday, December 27–28. At this meeting President Brown will deliver his retiring address, on "The relation of mathematics to the natural sciences." A regular meeting of the society will also be held in Chicago December 22–23. The San Francisco Section will meet at the University of California on Saturday, November 25. The Southwestern Section will meet at the University of Kansas on Saturday, December 2.

F. N. Cole,
Secretary